FIG. 1

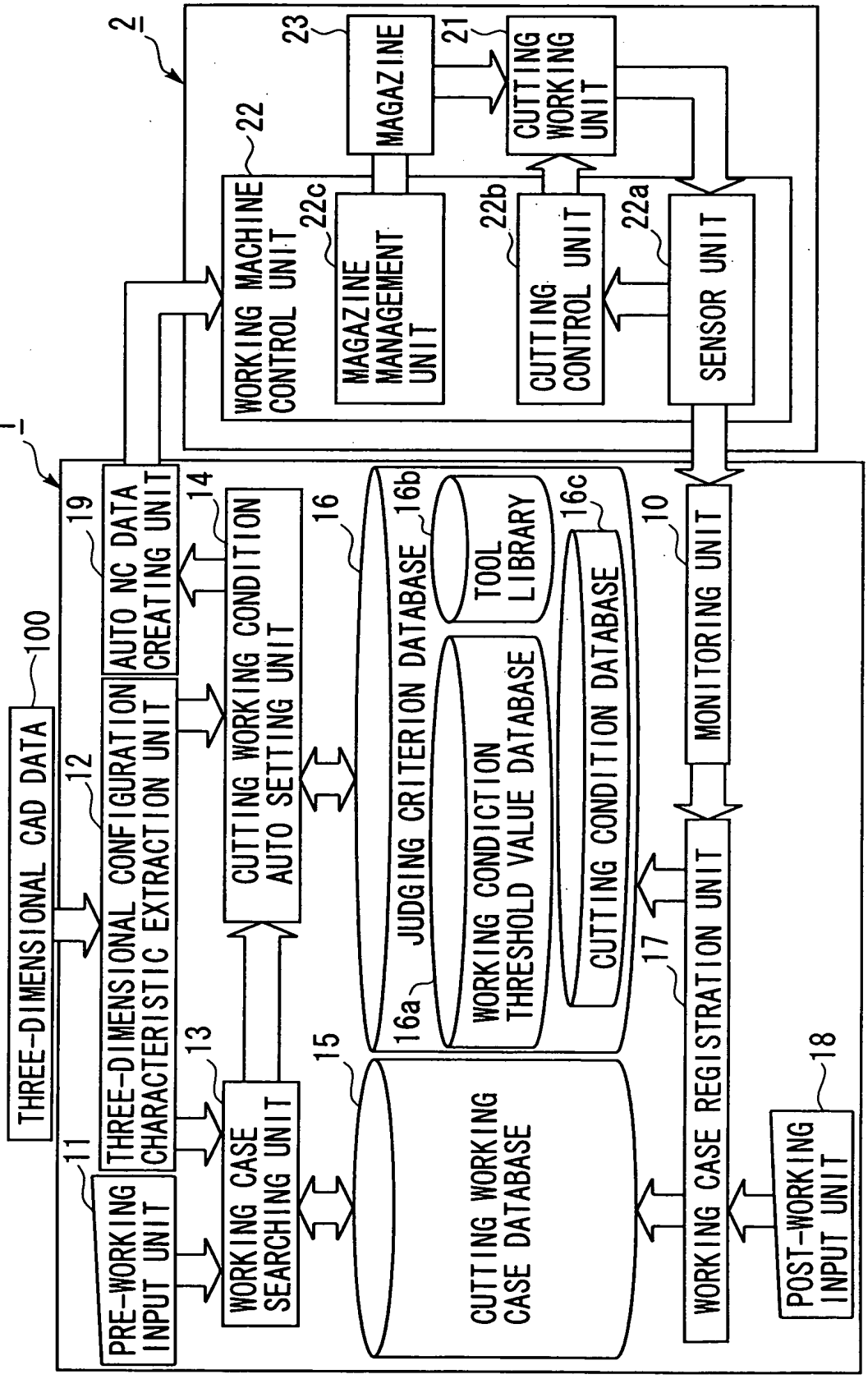

1
2
100
THREE-DIMENSIONAL CAD DATA
11
PRE-WORKING INPUT UNIT
12
THREE-DIMENSIONAL CONFIGURATION CHARACTERISTIC EXTRACTION UNIT
13
WORKING CASE SEARCHING UNIT
14
CUTTING WORKING CONDITION AUTO SETTING UNIT
15
CUTTING WORKING CASE DATABASE
16
16a JUDGING CRITERION DATABASE
16b TOOL LIBRARY
WORKING CONDICTION THRESHOLD VALUE DATABASE
16c CUTTING CONDITION DATABASE
17
WORKING CASE REGISTRATION UNIT
18
POST-WORKING INPUT UNIT
19
AUTO NC DATA CREATING UNIT
10
MONITORING UNIT
22
WORKING MACHINE CONTROL UNIT
22c MAGAZINE MANAGEMENT UNIT
22b CUTTING CONTROL UNIT
22a SENSOR UNIT
23
MAGAZINE
21
CUTTING WORKING UNIT

FIG. 2

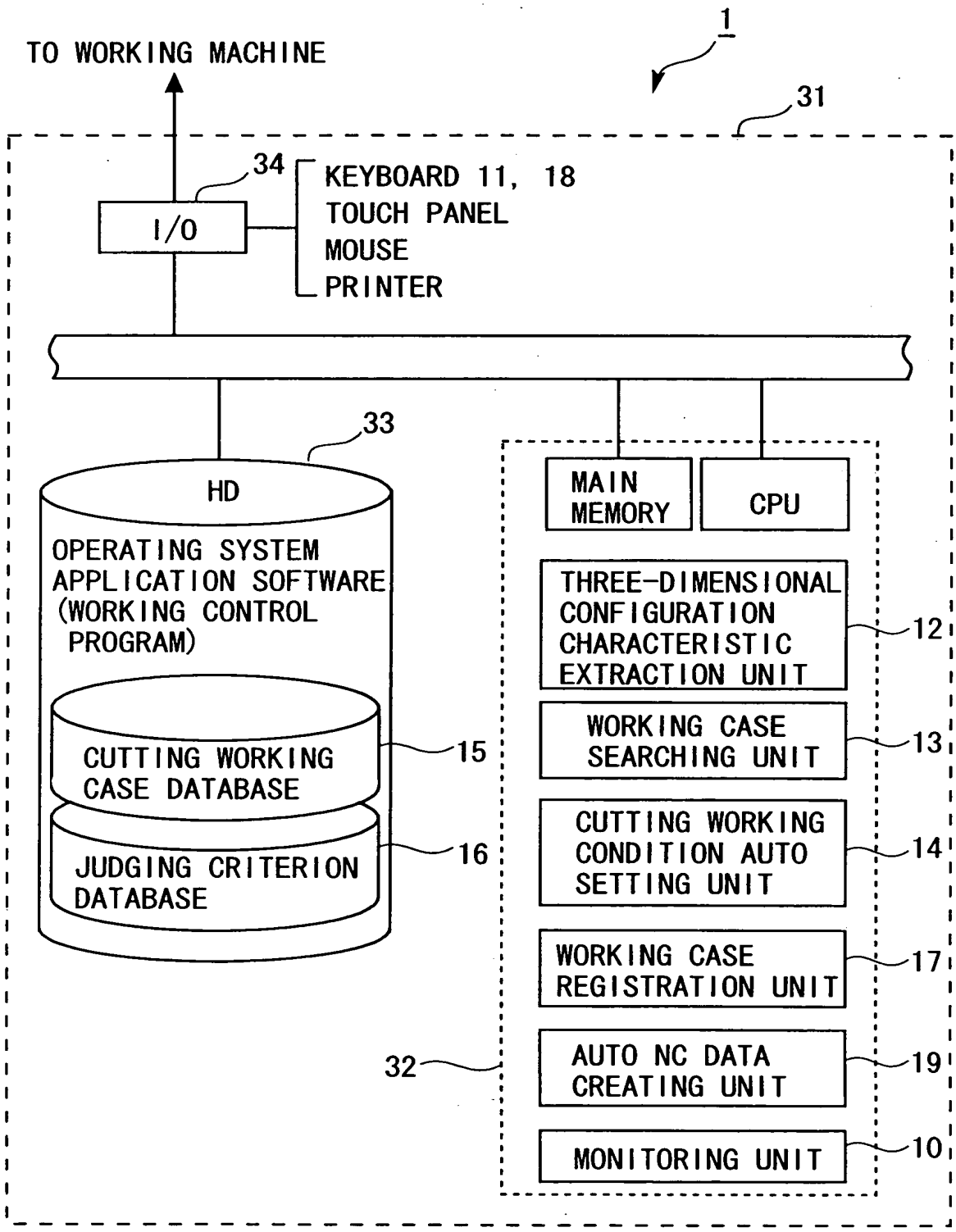

TO WORKING MACHINE
1
31
34
I/O
KEYBOARD 11, 18
TOUCH PANEL
MOUSE
PRINTER
33
HD
OPERATING SYSTEM
APPLICATION SOFTWARE
(WORKING CONTROL
PROGRAM)
CUTTING WORKING
CASE DATABASE
15
JUDGING CRITERION
DATABASE
16
MAIN
MEMORY
CPU
THREE-DIMENSIONAL
CONFIGURATION
CHARACTERISTIC
EXTRACTION UNIT
12
WORKING CASE
SEARCHING UNIT
13
CUTTING WORKING
CONDITION AUTO
SETTING UNIT
14
WORKING CASE
REGISTRATION UNIT
17
32
AUTO NC DATA
CREATING UNIT
19
MONITORING UNIT
10

FIG. 3

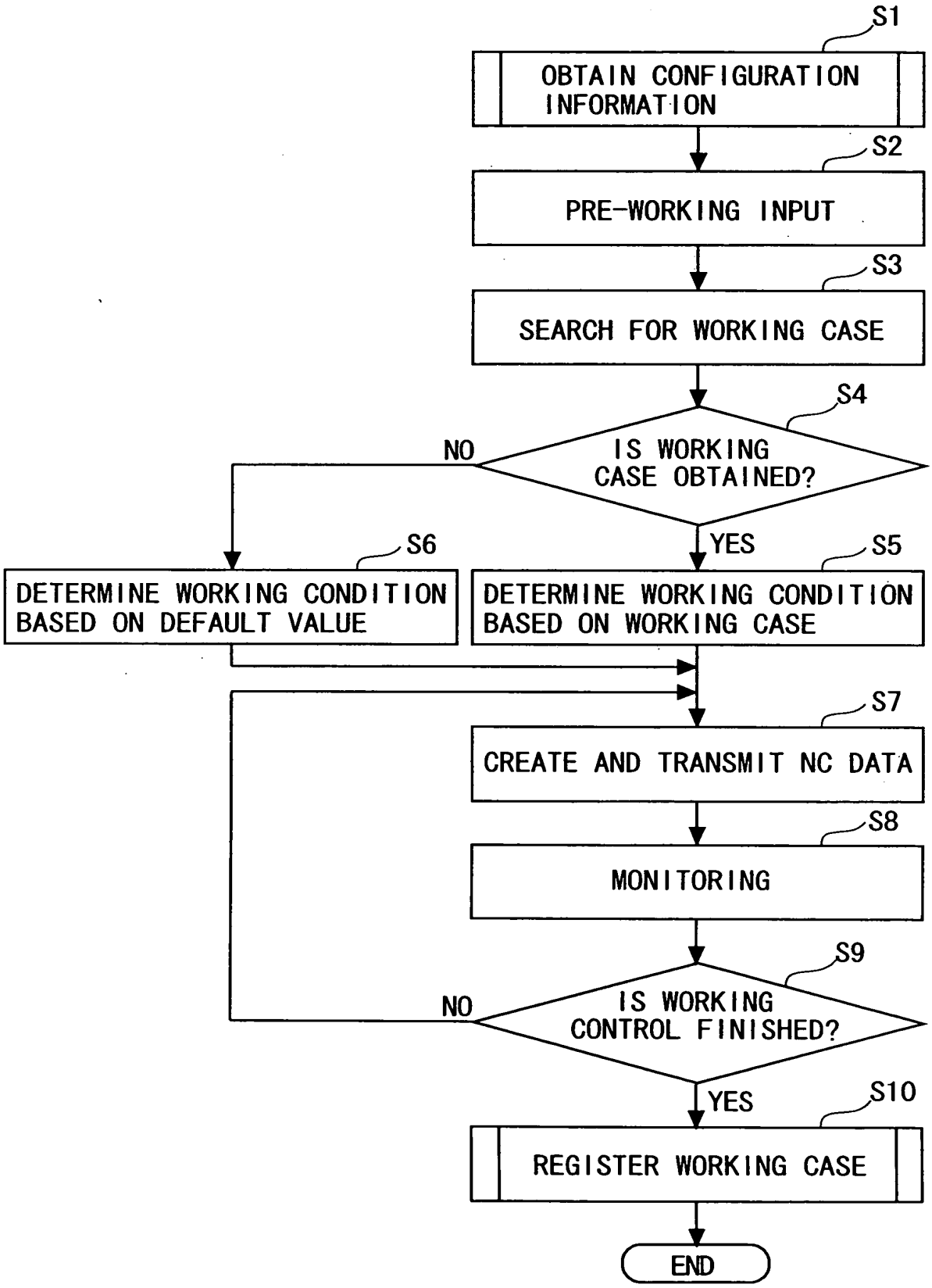

S1
OBTAIN CONFIGURATION INFORMATION
S2
PRE-WORKING INPUT
S3
SEARCH FOR WORKING CASE
S4
IS WORKING CASE OBTAINED?
NO
YES
S5
DETERMINE WORKING CONDITION BASED ON WORKING CASE
S6
DETERMINE WORKING CONDITION BASED ON DEFAULT VALUE
S7
CREATE AND TRANSMIT NC DATA
S8
MONITORING
S9
IS WORKING CONTROL FINISHED?
NO
YES
S10
REGISTER WORKING CASE
END

FIG. 4

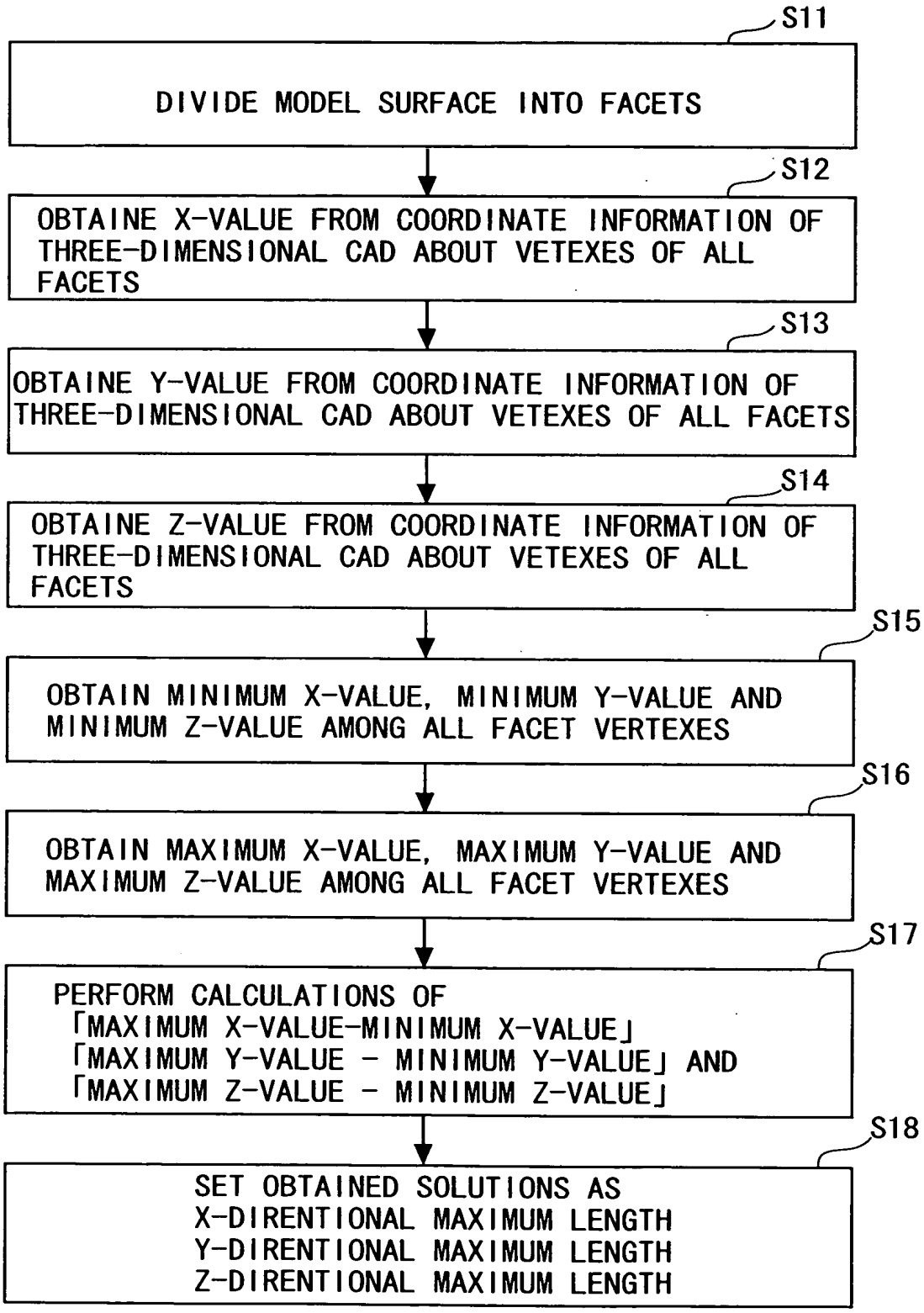

S11
DIVIDE MODEL SURFACE INTO FACETS
S12
OBTAINE X-VALUE FROM COORDINATE INFORMATION OF THREE-DIMENSIONAL CAD ABOUT VETEXES OF ALL FACETS
S13
OBTAINE Y-VALUE FROM COORDINATE INFORMATION OF THREE-DIMENSIONAL CAD ABOUT VETEXES OF ALL FACETS
S14
OBTAINE Z-VALUE FROM COORDINATE INFORMATION OF THREE-DIMENSIONAL CAD ABOUT VETEXES OF ALL FACETS
S15
OBTAIN MINIMUM X-VALUE, MINIMUM Y-VALUE AND MINIMUM Z-VALUE AMONG ALL FACET VERTEXES
S16
OBTAIN MAXIMUM X-VALUE, MAXIMUM Y-VALUE AND MAXIMUM Z-VALUE AMONG ALL FACET VERTEXES
S17
PERFORM CALCULATIONS OF
「MAXIMUM X-VALUE-MINIMUM X-VALUE」
「MAXIMUM Y-VALUE - MINIMUM Y-VALUE」 AND
「MAXIMUM Z-VALUE - MINIMUM Z-VALUE」
S18
SET OBTAINED SOLUTIONS AS
X-DIRENTIONAL MAXIMUM LENGTH
Y-DIRENTIONAL MAXIMUM LENGTH
Z-DIRENTIONAL MAXIMUM LENGTH

FIG. 5A

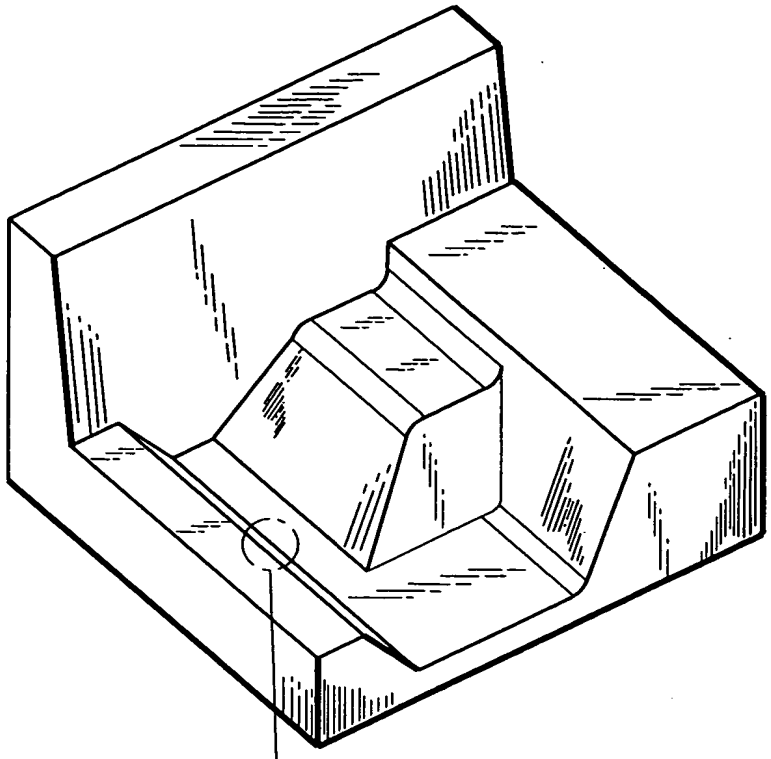


FIG. 5B

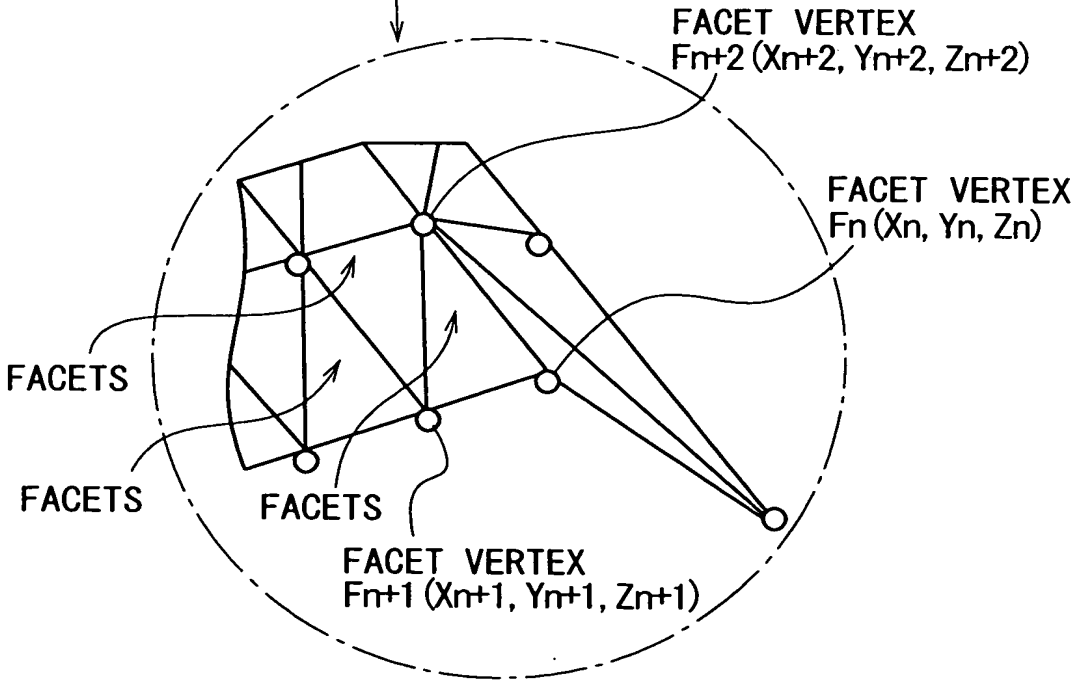

FACET VERTEX
Fn+2 (Xn+2, Yn+2, Zn+2)
FACET VERTEX
Fn (Xn, Yn, Zn)
FACETS
FACETS
FACETS
FACET VERTEX
Fn+1 (Xn+1, Yn+1, Zn+1)

FIG. 6

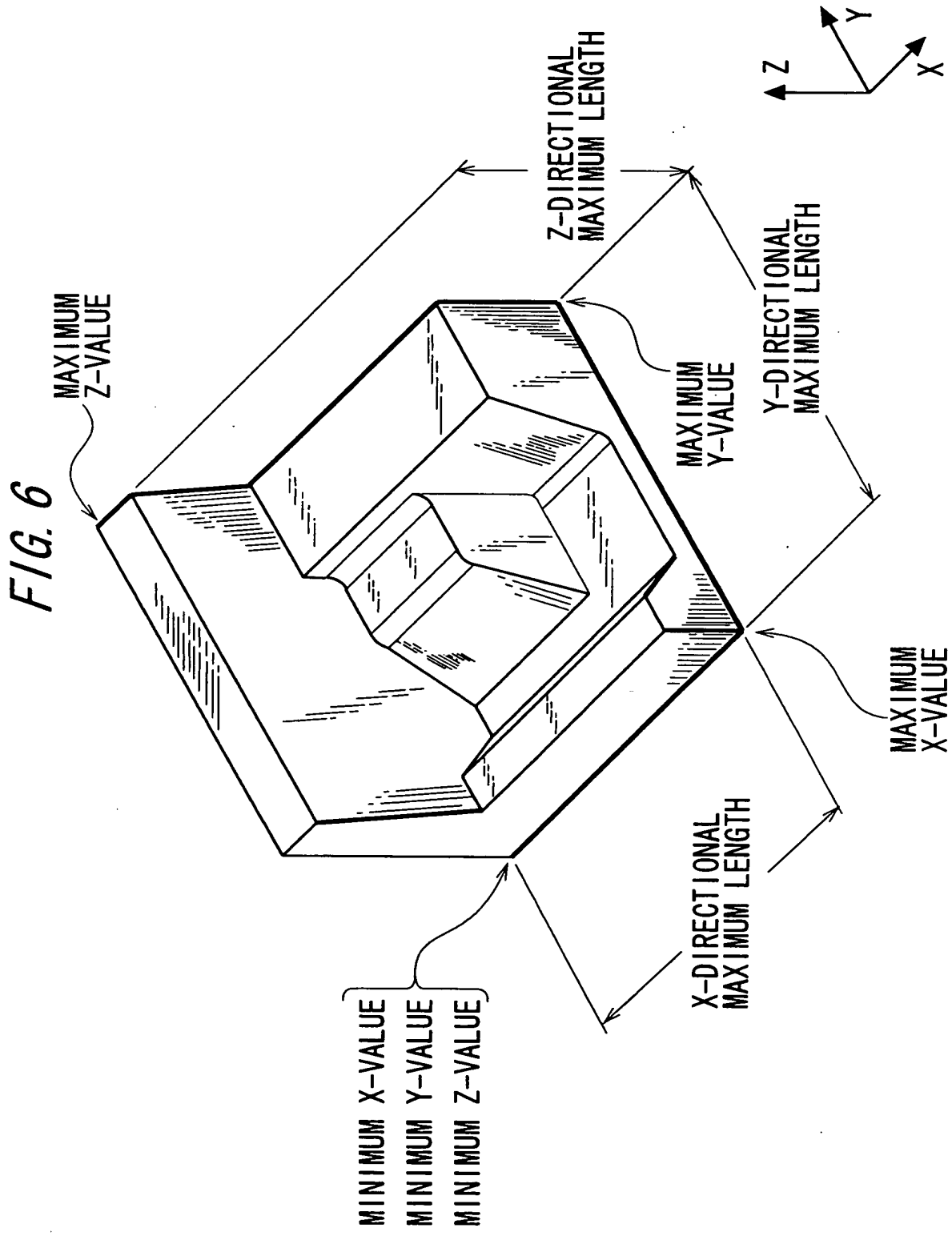

MAXIMUM Z-VALUE
Z-DIRECTIONAL MAXIMUM LENGTH
Z
Y
X
MAXIMUM Y-VALUE
Y-DIRECTIONAL MAXIMUM LENGTH
MAXIMUM X-VALUE
X-DIRECTIONAL MAXIMUM LENGTH
MINIMUM X-VALUE
MINIMUM Y-VALUE
MINIMUM Z-VALUE

FIG. 7

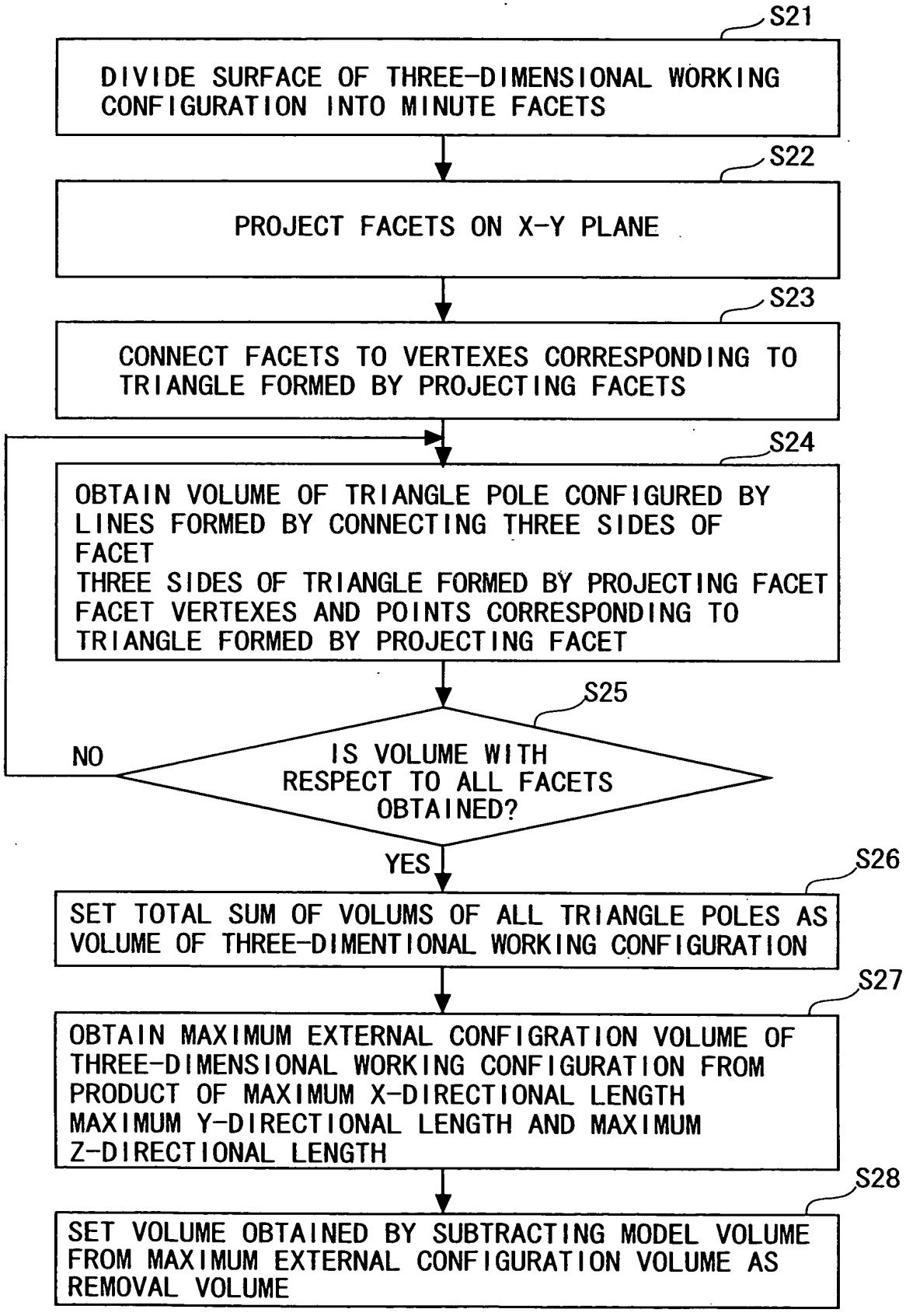
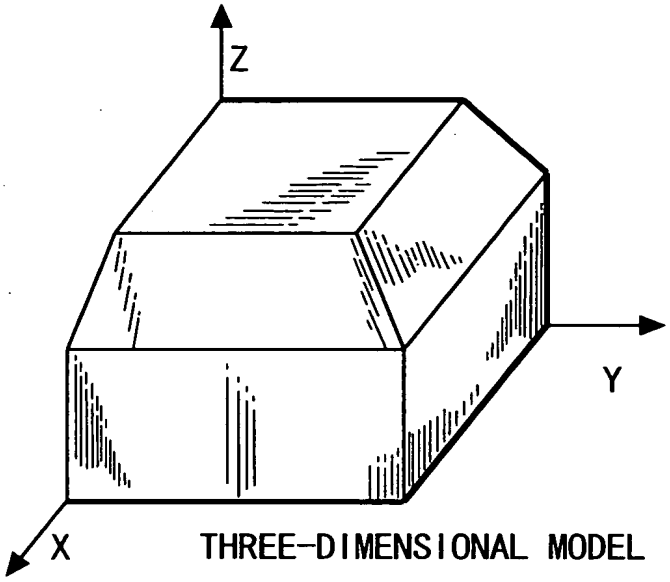
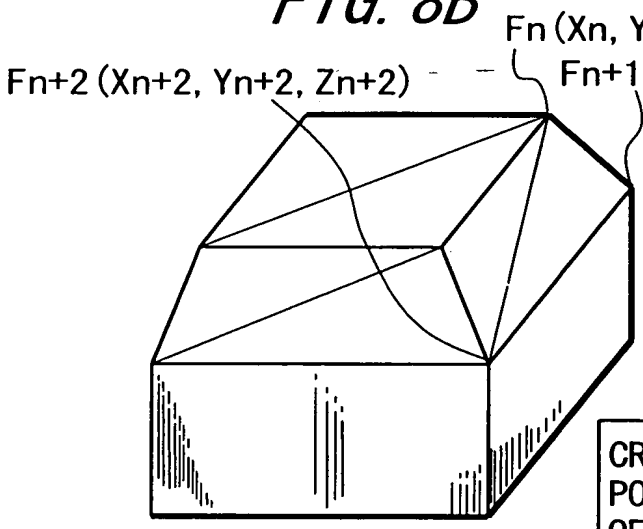

S21
DIVIDE SURFACE OF THREE-DIMENSIONAL WORKING CONFIGURATION INTO MINUTE FACETS
S22
PROJECT FACETS ON X-Y PLANE
S23
CONNECT FACETS TO VERTEXES CORRESPONDING TO TRIANGLE FORMED BY PROJECTING FACETS
S24
OBTAIN VOLUME OF TRIANGLE POLE CONFIGURED BY LINES FORMED BY CONNECTING THREE SIDES OF FACET
THREE SIDES OF TRIANGLE FORMED BY PROJECTING FACET
FACET VERTEXES AND POINTS CORRESPONDING TO TRIANGLE FORMED BY PROJECTING FACET
S25
IS VOLUME WITH RESPECT TO ALL FACETS OBTAINED?
NO
YES
S26
SET TOTAL SUM OF VOLUMS OF ALL TRIANGLE POLES AS VOLUME OF THREE-DIMENTIONAL WORKING CONFIGURATION
S27
OBTAIN MAXIMUM EXTERNAL CONFIGRATION VOLUME OF THREE-DIMENSIONAL WORKING CONFIGURATION FROM PRODUCT OF MAXIMUM X-DIRECTIONAL LENGTH MAXIMUM Y-DIRECTIONAL LENGTH AND MAXIMUM Z-DIRECTIONAL LENGTH
S28
SET VOLUME OBTAINED BY SUBTRACTING MODEL VOLUME FROM MAXIMUM EXTERNAL CONFIGURATION VOLUME AS REMOVAL VOLUME

FIG. 8A



THREE-DIMENSIONAL MODEL

FIG. 8B



MODEL WITH SURFACE DIVIDED INTO FACETS

CREATE TRIANGLE POLE FROM SIX PIECES OF VERTEXES

FIG. 8D

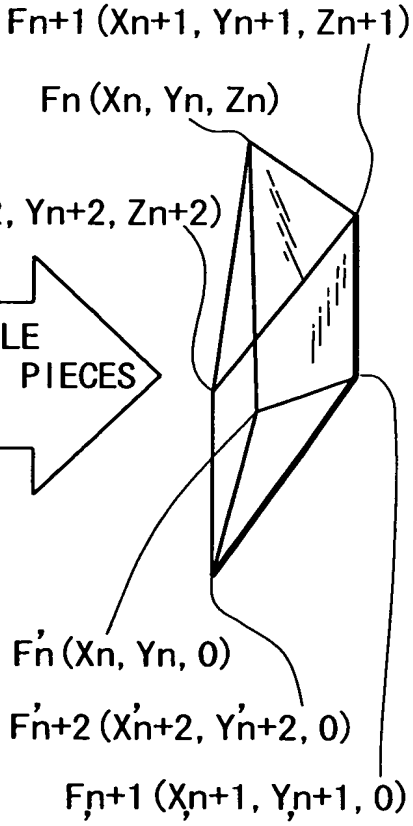
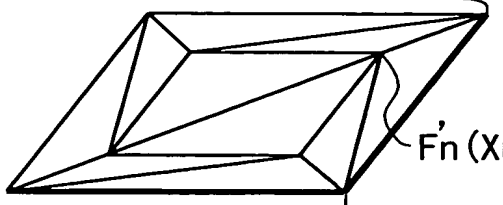


FIG. 8C



PROJECT FACETS ON X-Y PLANE

FIG. 9A

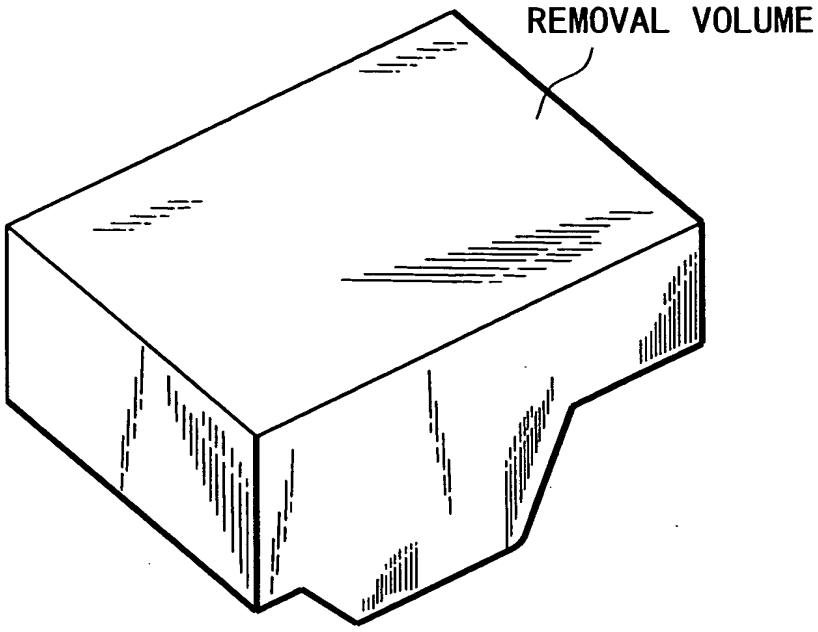

REMOVAL VOLUME

FIG. 9B

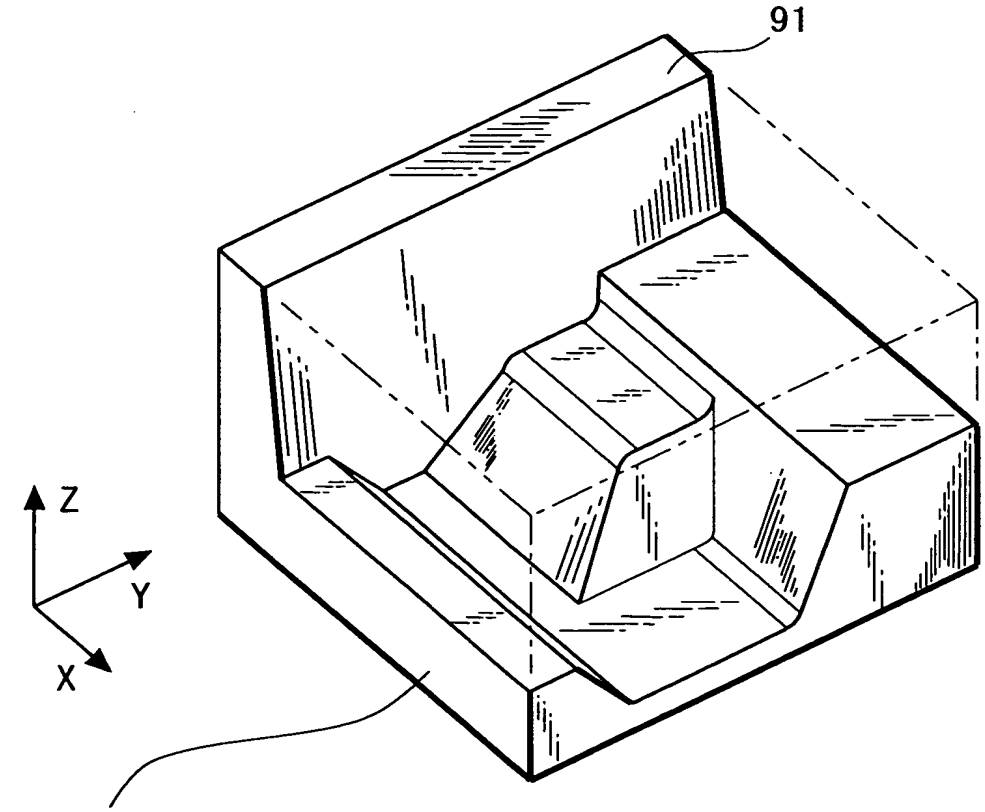

91
Z
Y
X
THREE-DIMENSIONAL WORKING CONFIGURATION VOLUME

FIG. 10

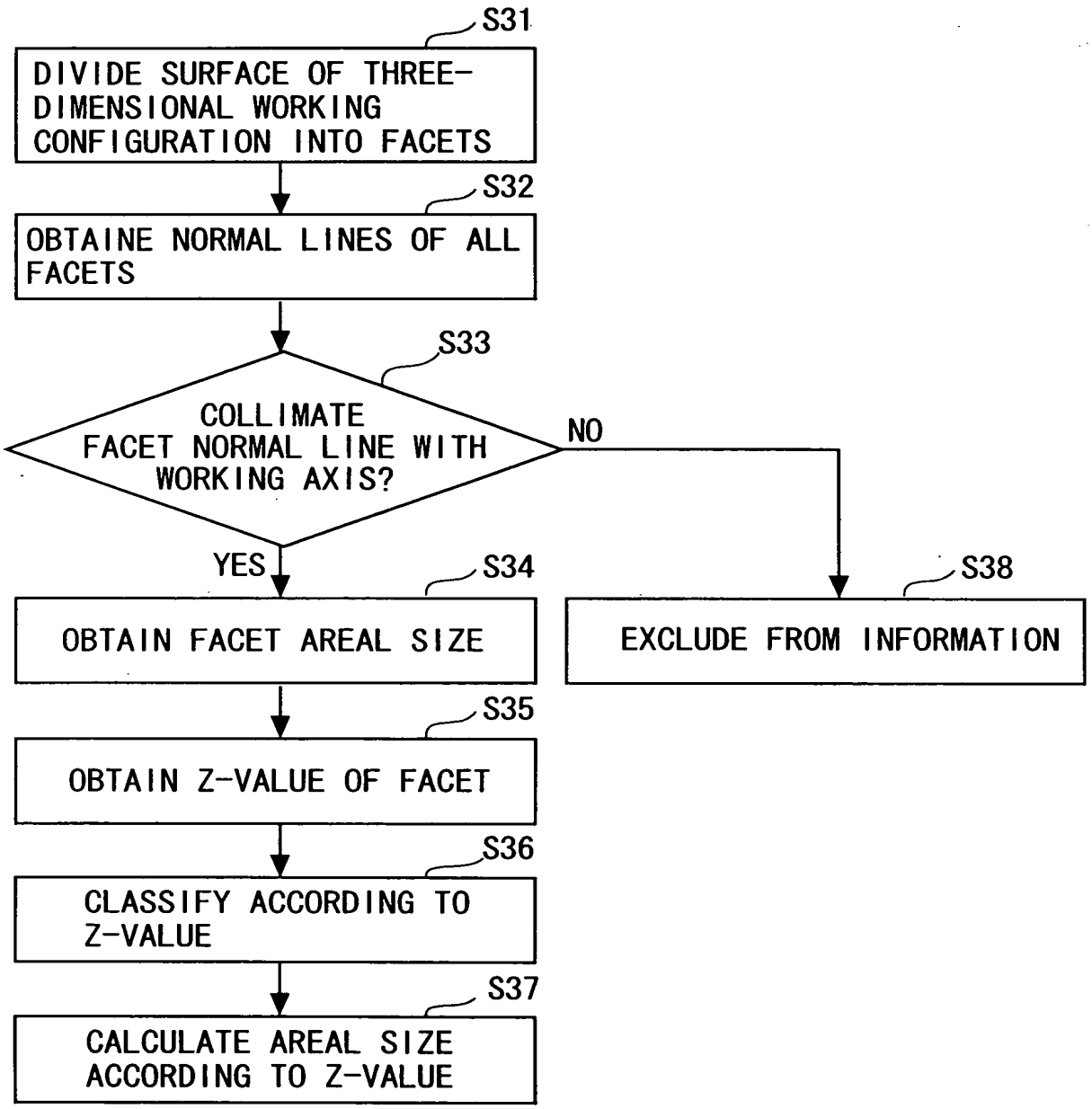

S31
DIVIDE SURFACE OF THREE-DIMENSIONAL WORKING CONFIGURATION INTO FACETS
S32
OBTAINE NORMAL LINES OF ALL FACETS
S33
COLLIMATE FACET NORMAL LINE WITH WORKING AXIS?
NO
YES
S34
OBTAIN FACET AREAL SIZE
S38
EXCLUDE FROM INFORMATION
S35
OBTAIN Z-VALUE OF FACET
S36
CLASSIFY ACCORDING TO Z-VALUE
S37
CALCULATE AREAL SIZE ACCORDING TO Z-VALUE

FIG. 11

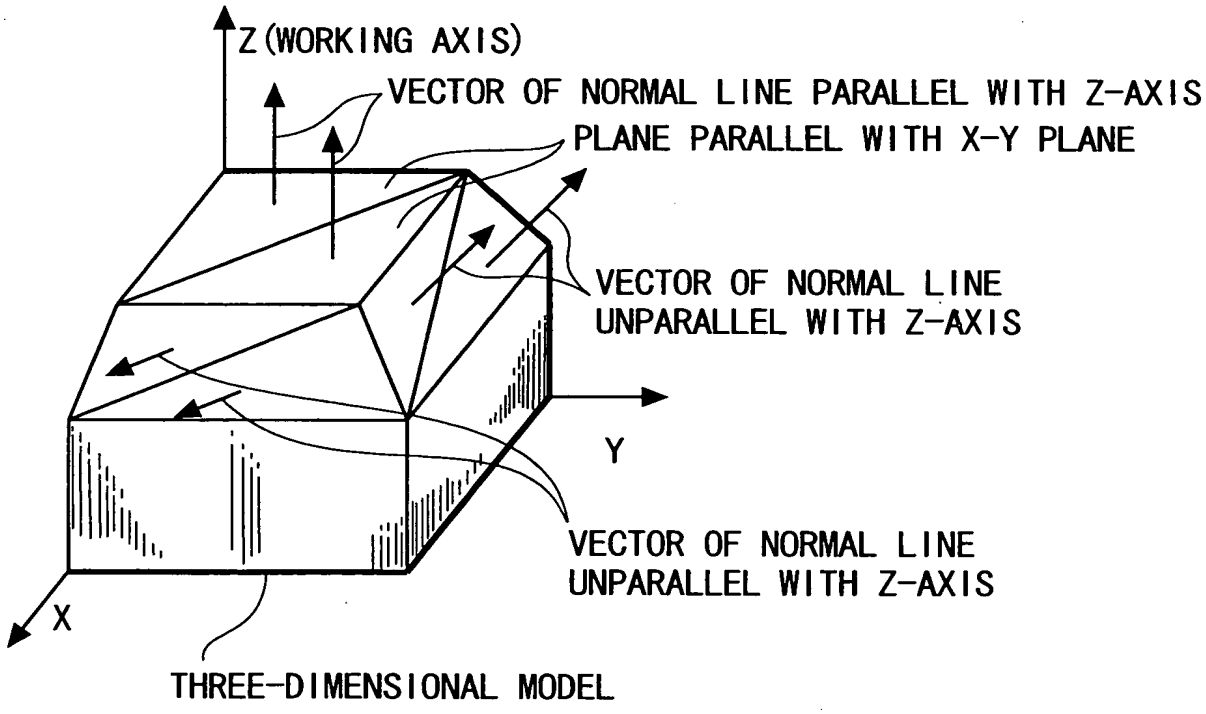

Z (WORKING AXIS)
VECTOR OF NORMAL LINE PARALLEL WITH Z-AXIS
PLANE PARALLEL WITH X-Y PLANE
VECTOR OF NORMAL LINE
UNPARALLEL WITH Z-AXIS
Y
VECTOR OF NORMAL LINE
UNPARALLEL WITH Z-AXIS
X
THREE-DIMENSIONAL MODEL

FIG. 12

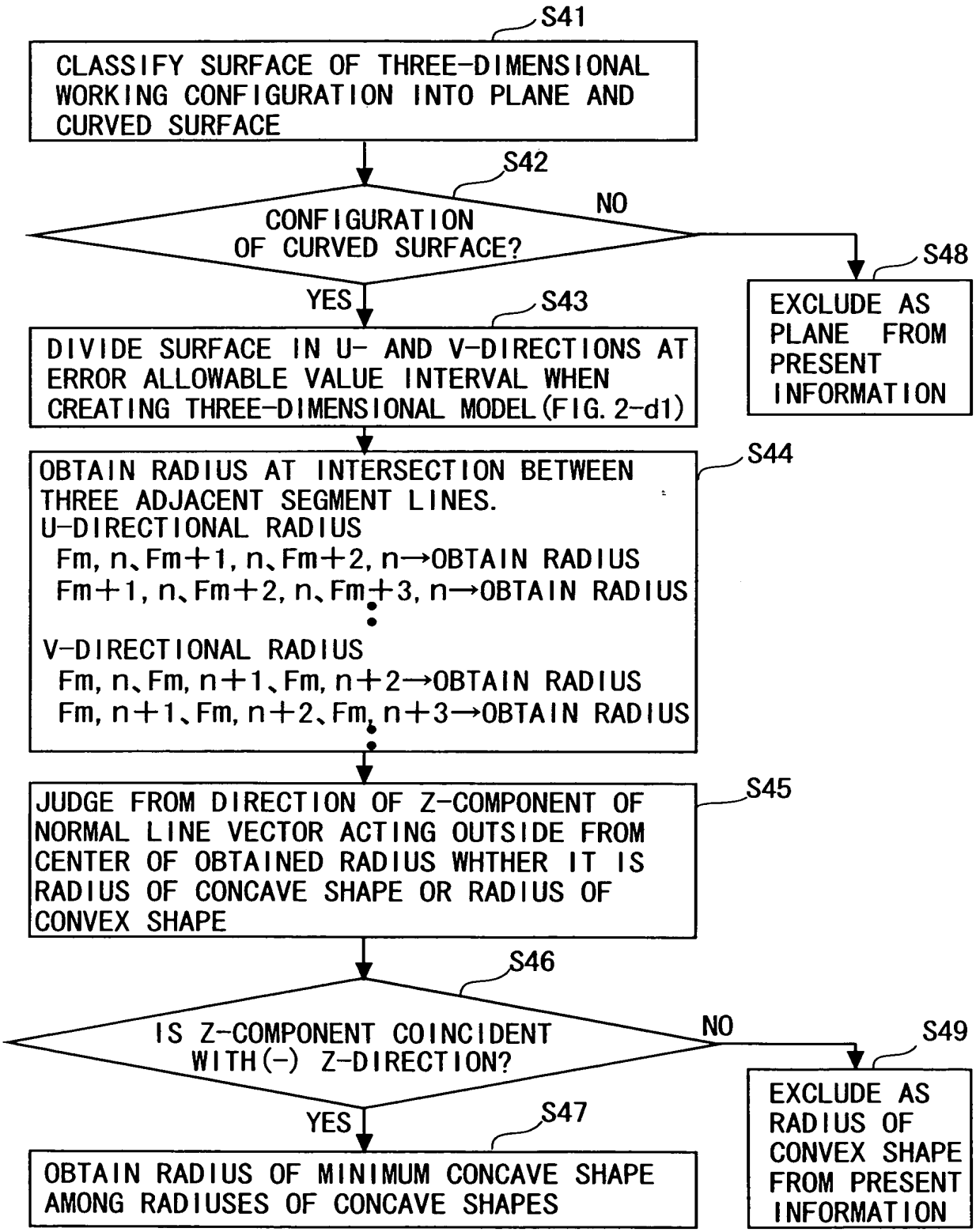

S41
CLASSIFY SURFACE OF THREE-DIMENSIONAL WORKING CONFIGURATION INTO PLANE AND CURVED SURFACE
S42
CONFIGURATION OF CURVED SURFACE?
NO
YES
S48
EXCLUDE AS PLANE FROM PRESENT INFORMATION
S43
DIVIDE SURFACE IN U- AND V-DIRECTIONS AT ERROR ALLOWABLE VALUE INTERVAL WHEN CREATING THREE-DIMENSIONAL MODEL (FIG. 2-d1)
S44
OBTAIN RADIUS AT INTERSECTION BETWEEN THREE ADJACENT SEGMENT LINES.
U-DIRECTIONAL RADIUS
Fm, n、Fm+1, n、Fm+2, n→OBTAIN RADIUS
Fm+1, n、Fm+2, n、Fm+3, n→OBTAIN RADIUS
V-DIRECTIONAL RADIUS
Fm, n、Fm, n+1、Fm, n+2→OBTAIN RADIUS
Fm, n+1、Fm, n+2、Fm, n+3→OBTAIN RADIUS
S45
JUDGE FROM DIRECTION OF Z-COMPONENT OF NORMAL LINE VECTOR ACTING OUTSIDE FROM CENTER OF OBTAINED RADIUS WHTHER IT IS RADIUS OF CONCAVE SHAPE OR RADIUS OF CONVEX SHAPE
S46
IS Z-COMPONENT COINCIDENT WITH(-) Z-DIRECTION?
NO
YES
S49
EXCLUDE AS RADIUS OF CONVEX SHAPE FROM PRESENT INFORMATION
S47
OBTAIN RADIUS OF MINIMUM CONCAVE SHAPE AMONG RADIUSES OF CONCAVE SHAPES

FIG. 13A

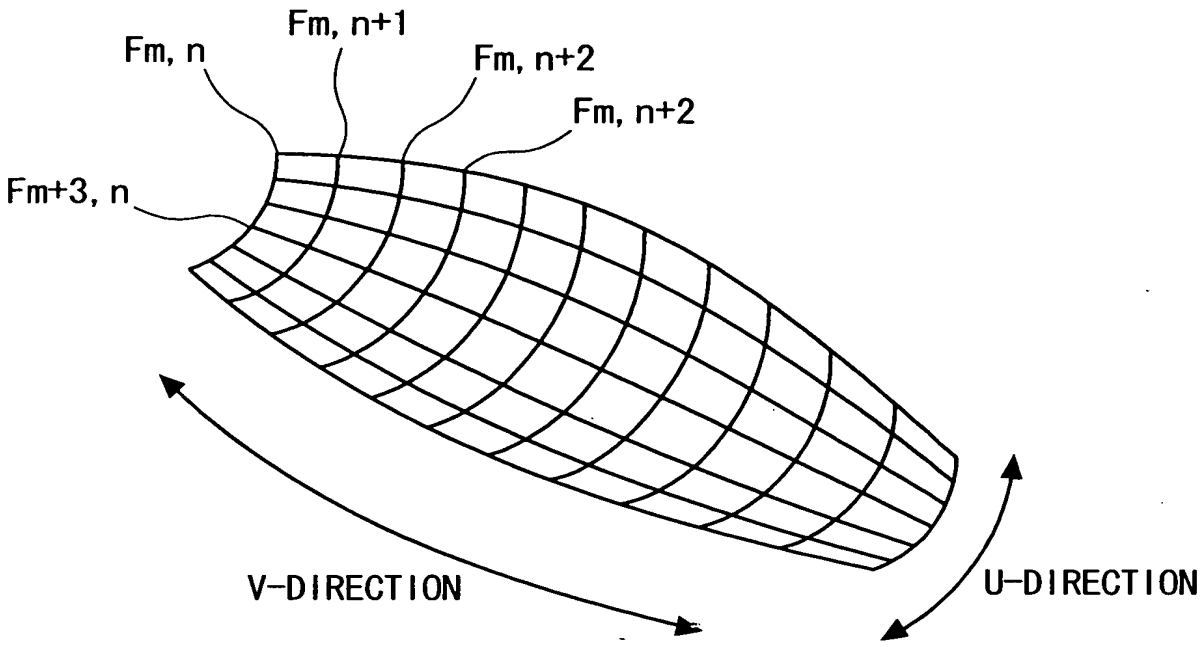


FIG. 13B

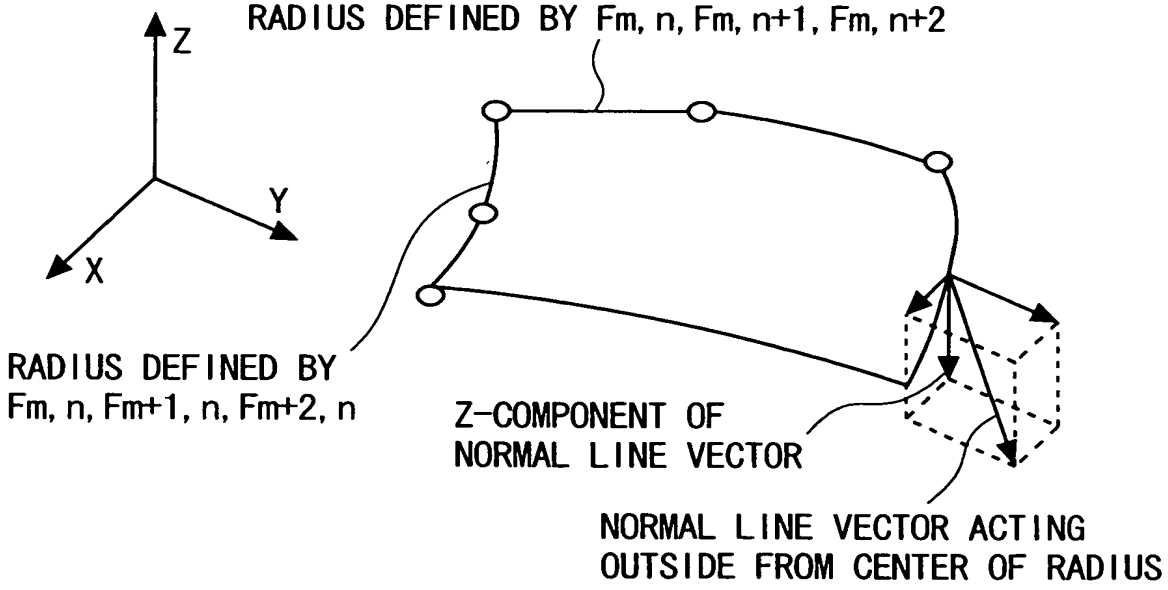


FIG. 14

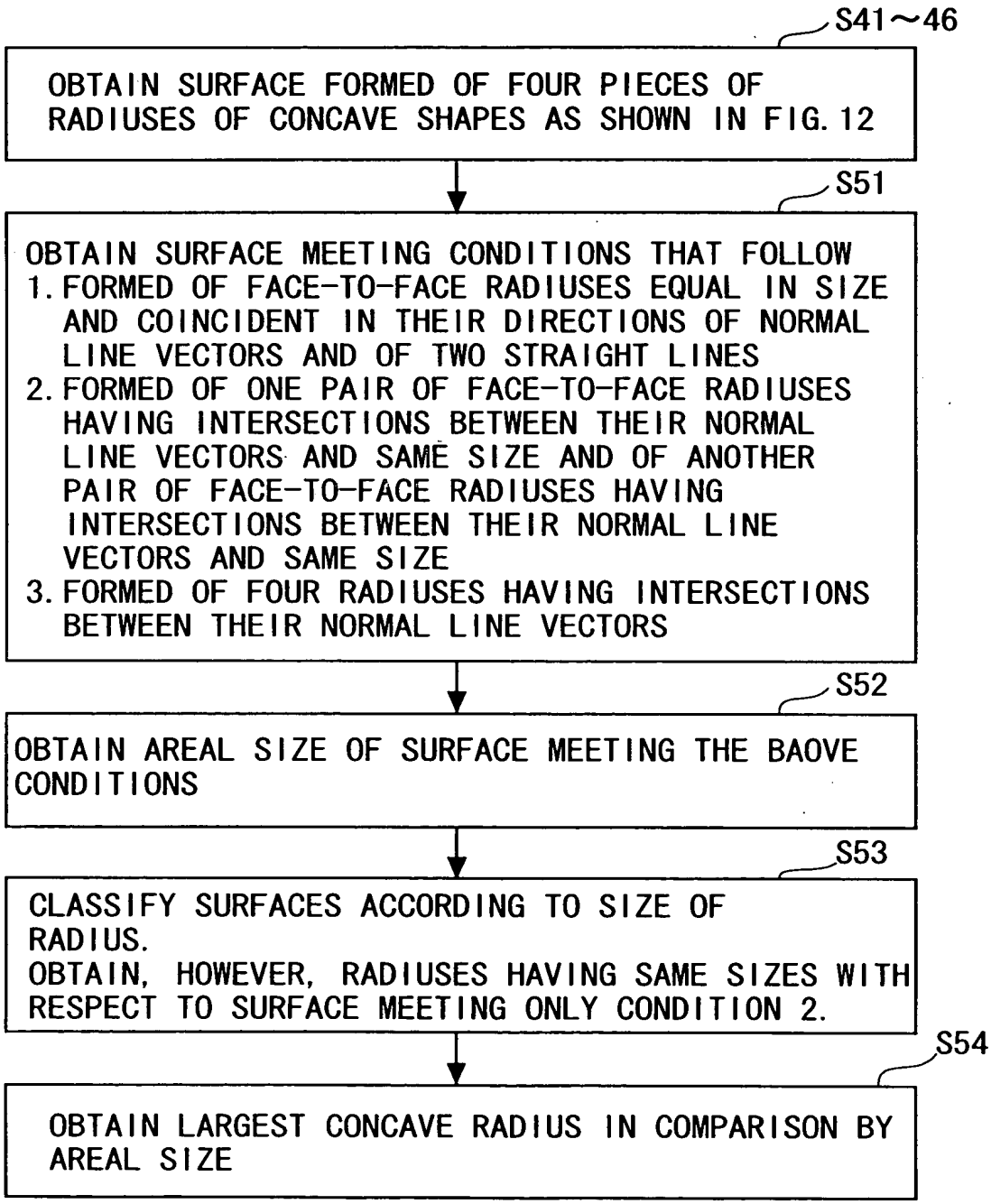

S41~46
OBTAIN SURFACE FORMED OF FOUR PIECES OF RADIUSES OF CONCAVE SHAPES AS SHOWN IN FIG. 12
S51
OBTAIN SURFACE MEETING CONDITIONS THAT FOLLOW
1. FORMED OF FACE-TO-FACE RADIUSES EQUAL IN SIZE AND COINCIDENT IN THEIR DIRECTIONS OF NORMAL LINE VECTORS AND OF TWO STRAIGHT LINES
2. FORMED OF ONE PAIR OF FACE-TO-FACE RADIUSES HAVING INTERSECTIONS BETWEEN THEIR NORMAL LINE VECTORS AND SAME SIZE AND OF ANOTHER PAIR OF FACE-TO-FACE RADIUSES HAVING INTERSECTIONS BETWEEN THEIR NORMAL LINE VECTORS AND SAME SIZE
3. FORMED OF FOUR RADIUSES HAVING INTERSECTIONS BETWEEN THEIR NORMAL LINE VECTORS
S52
OBTAIN AREAL SIZE OF SURFACE MEETING THE BAOVE CONDITIONS
S53
CLASSIFY SURFACES ACCORDING TO SIZE OF RADIUS.
OBTAIN, HOWEVER, RADIUSES HAVING SAME SIZES WITH RESPECT TO SURFACE MEETING ONLY CONDITION 2.
S54
OBTAIN LARGEST CONCAVE RADIUS IN COMPARISON BY AREAL SIZE

FIG. 15A

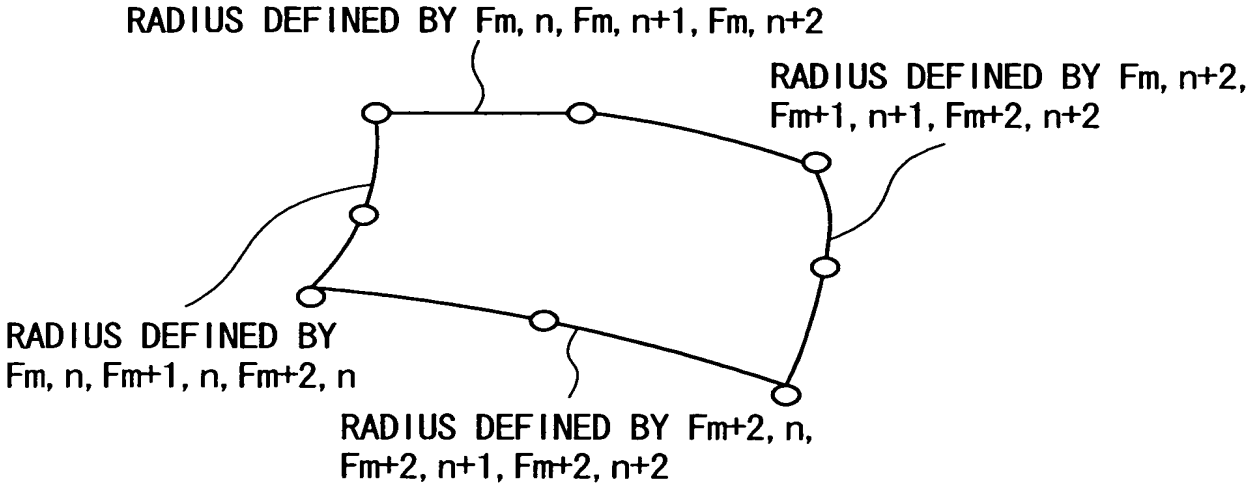


FIG. 15B

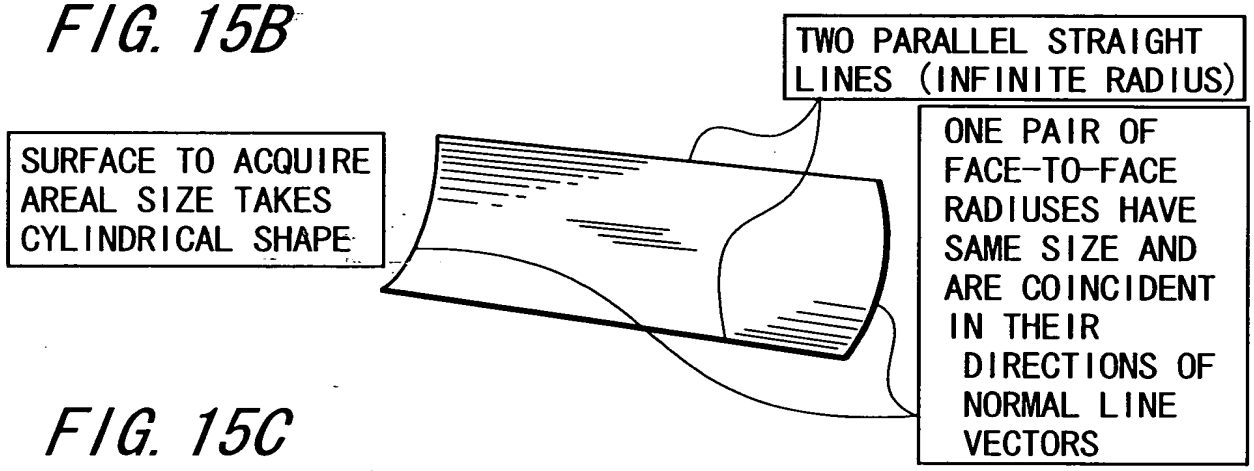


FIG. 15C

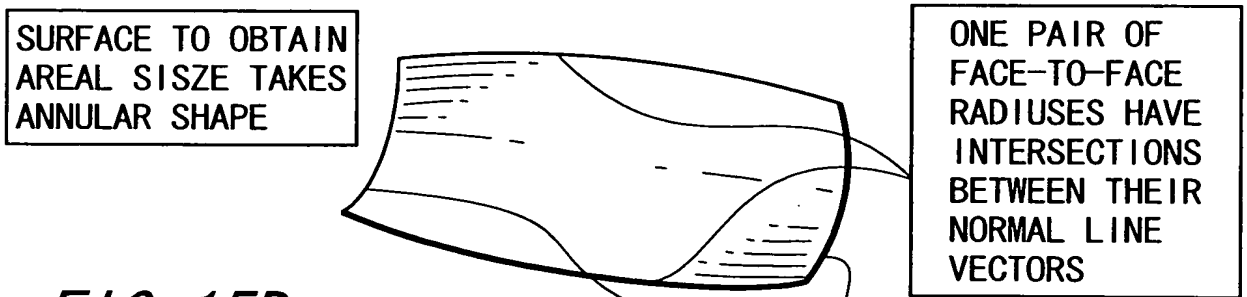


FIG. 15D

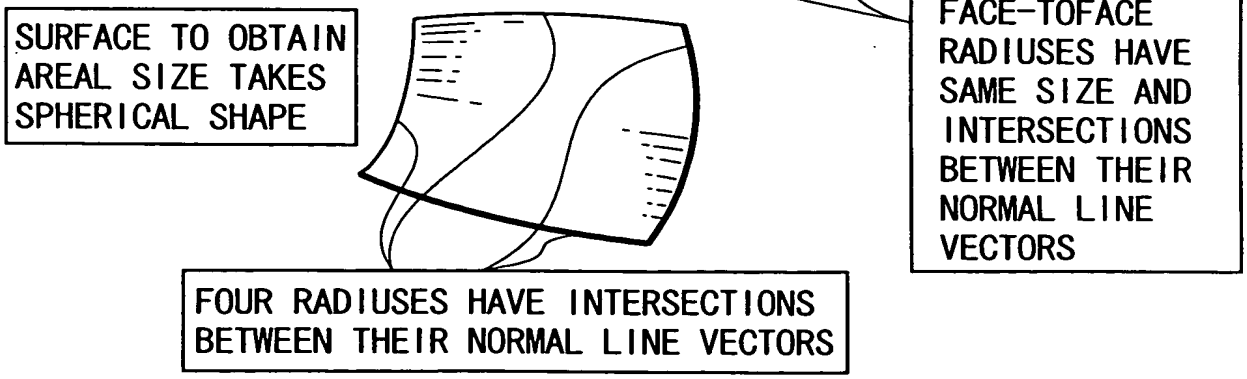


FIG. 16

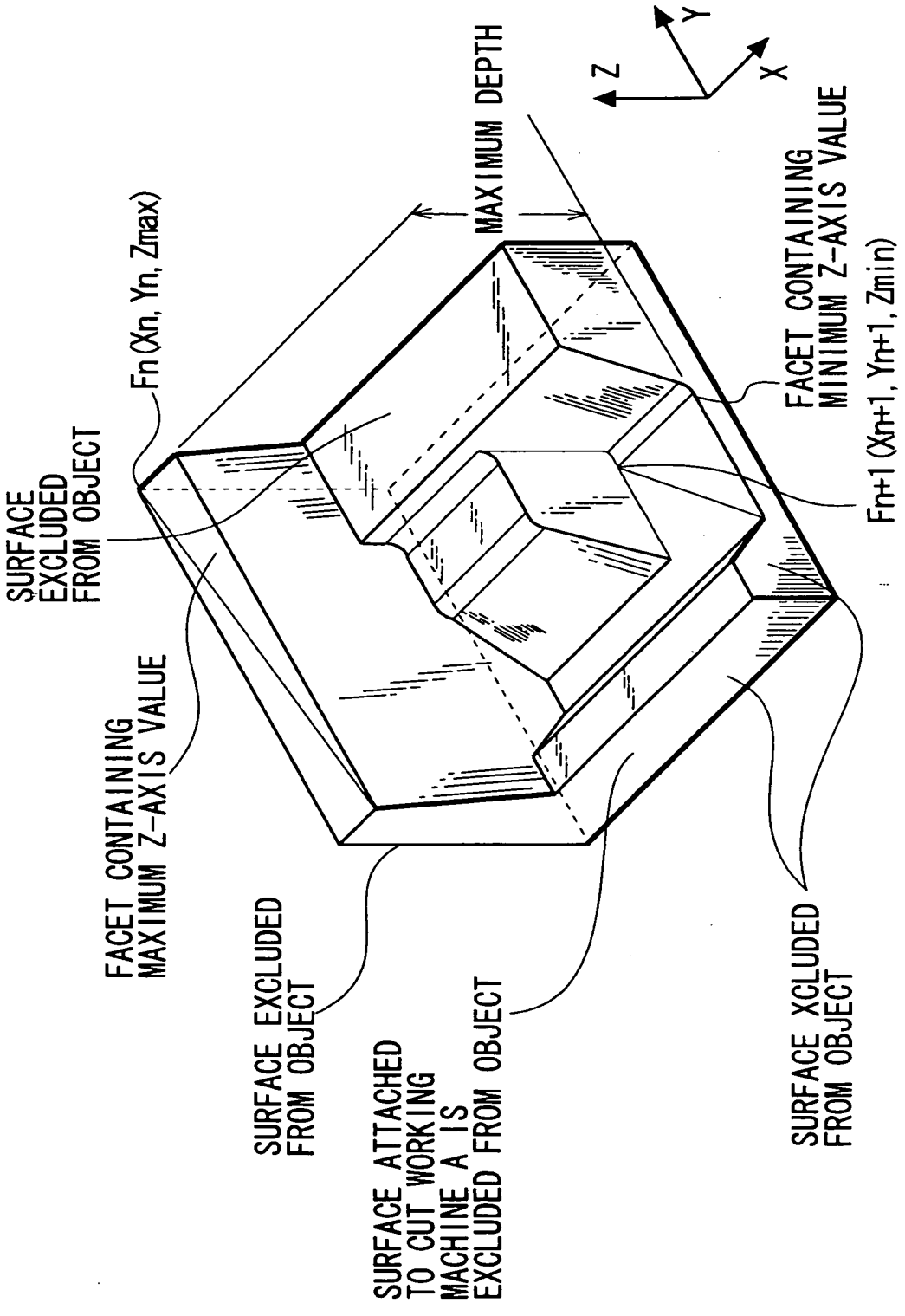
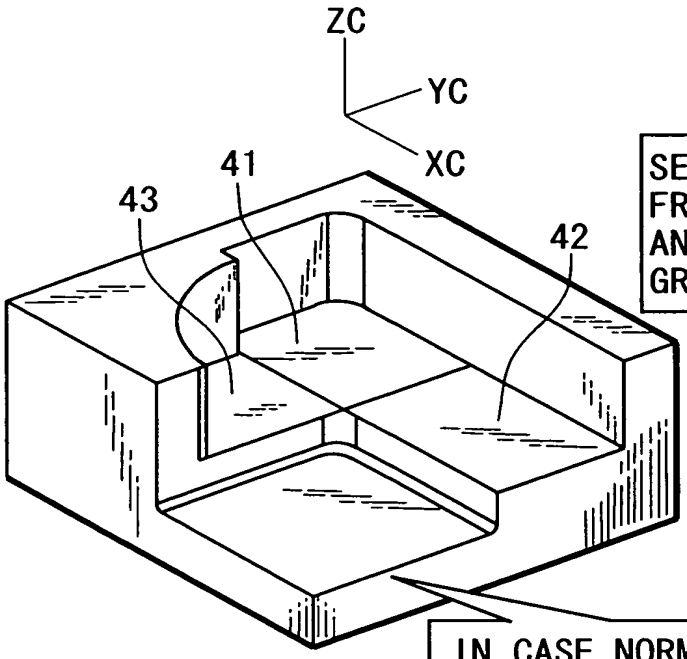

Z
Y
X
MAXIMUM DEPTH
Fn (Xn, Yn, Zmax)
SURFACE EXCLUDED FROM OBJECT
FACET CONTAINING MAXIMUM Z-AXIS VALUE
FACET CONTAINING MINIMUM Z-AXIS VALUE
Fn+1 (Xn+1, Yn+1, Zmin)
SURFACE EXCLUDED FROM OBJECT
SURFACE ATTACHED TO CUT WORKING MACHINE A IS EXCLUDED FROM OBJECT
SURFACE XCLUDED FROM OBJECT

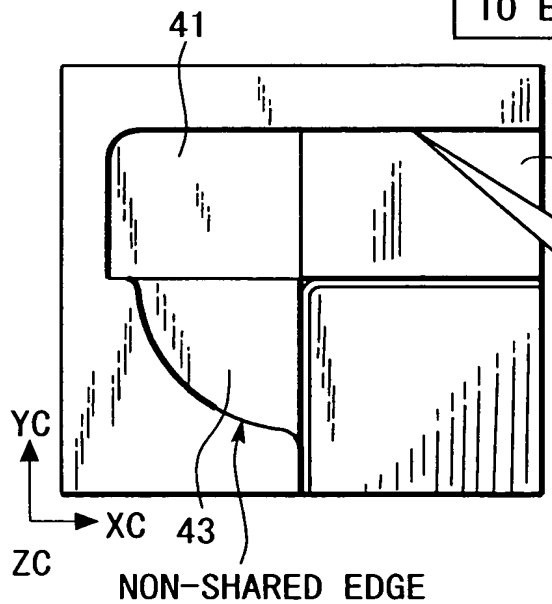
FIG. 17A



SEARCH FOR SAME SURFACE FROM SURFACE INFORMATION, AND DEFINE IT AS SURFACE GROUP

IN CASE NORMAL LINE VECTORS IN WORKING HORIZONTAL DIRECTION ARE PARALLEL AT POINTS ON RESPECTIVE SURFACE DGES, IT IS JUDGED THAT EDGES ARE SHARED. →SURFACES THEREOF ARE ADJACENT TO EACH OTHER.

FIG. 17B



CHECK EDGES WITH RESPECT TO EACH OF SURFACES WITHIN SAME SURFACE GROUP, AND EXTRACT EDGES UNSHARED WITH OTHER SURFACES.

IN CASE EDGE OF EACH SURFACE IS NOT SHARED WITH OTHER SURFACES, IT IS DEEMED TO BE EXTERNAL CONFIGURATION EDGE OF SURFACE GROUP, AND SET THIS AS WORKING BOUNDARY.

NON-SHARED EDGE (WORKING BOUNDARY, AREA OF BOLD LINE)

3) SAME SEARCH IS MADE WITH RESPECT TO OTHER SURFACE GROUP, AND AUTOMATICALLY CREATE WORKING BOUNDARY.

FIG. 18

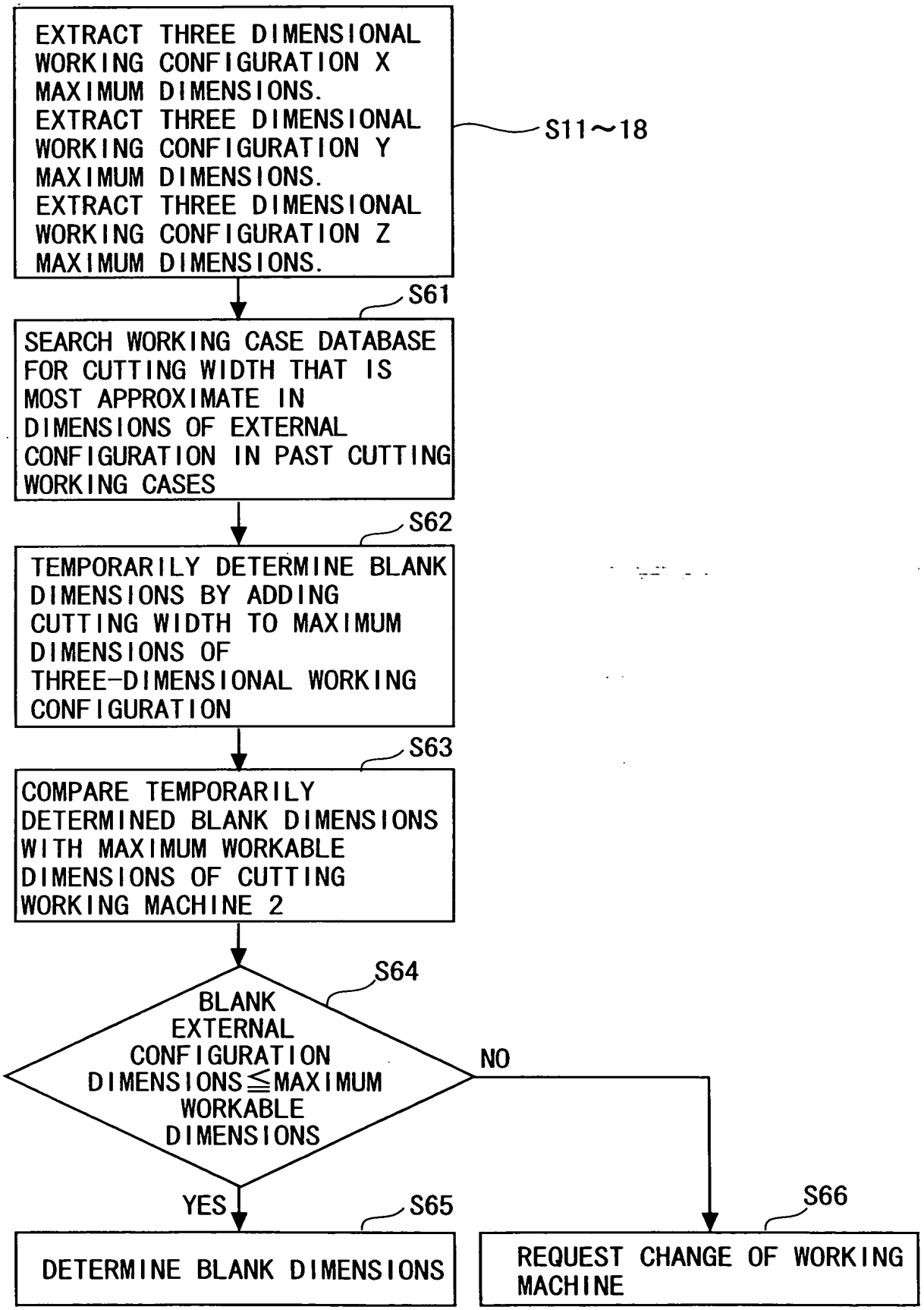

EXTRACT THREE DIMENSIONAL WORKING CONFIGURATION X MAXIMUM DIMENSIONS.
EXTRACT THREE DIMENSIONAL WORKING CONFIGURATION Y MAXIMUM DIMENSIONS.
EXTRACT THREE DIMENSIONAL WORKING CONFIGURATION Z MAXIMUM DIMENSIONS.
S11～18
S61
SEARCH WORKING CASE DATABASE FOR CUTTING WIDTH THAT IS MOST APPROXIMATE IN DIMENSIONS OF EXTERNAL CONFIGURATION IN PAST CUTTING WORKING CASES
S62
TEMPORARILY DETERMINE BLANK DIMENSIONS BY ADDING CUTTING WIDTH TO MAXIMUM DIMENSIONS OF THREE-DIMENSIONAL WORKING CONFIGURATION
S63
COMPARE TEMPORARILY DETERMINED BLANK DIMENSIONS WITH MAXIMUM WORKABLE DIMENSIONS OF CUTTING WORKING MACHINE 2
S64
BLANK EXTERNAL CONFIGURATION DIMENSIONS≦MAXIMUM WORKABLE DIMENSIONS
NO
YES
S65
DETERMINE BLANK DIMENSIONS
S66
REQUEST CHANGE OF WORKING MACHINE

FIG. 19

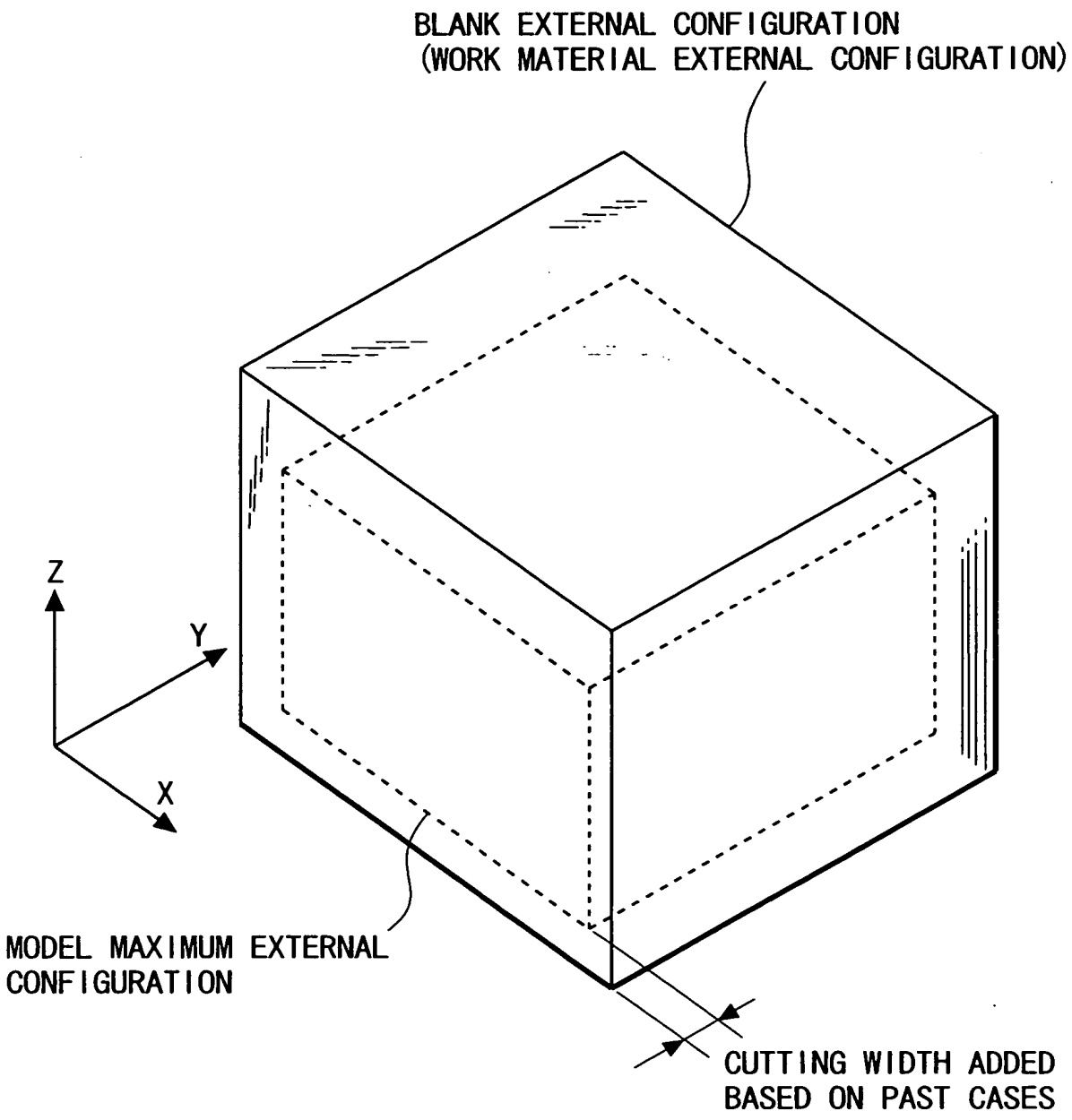
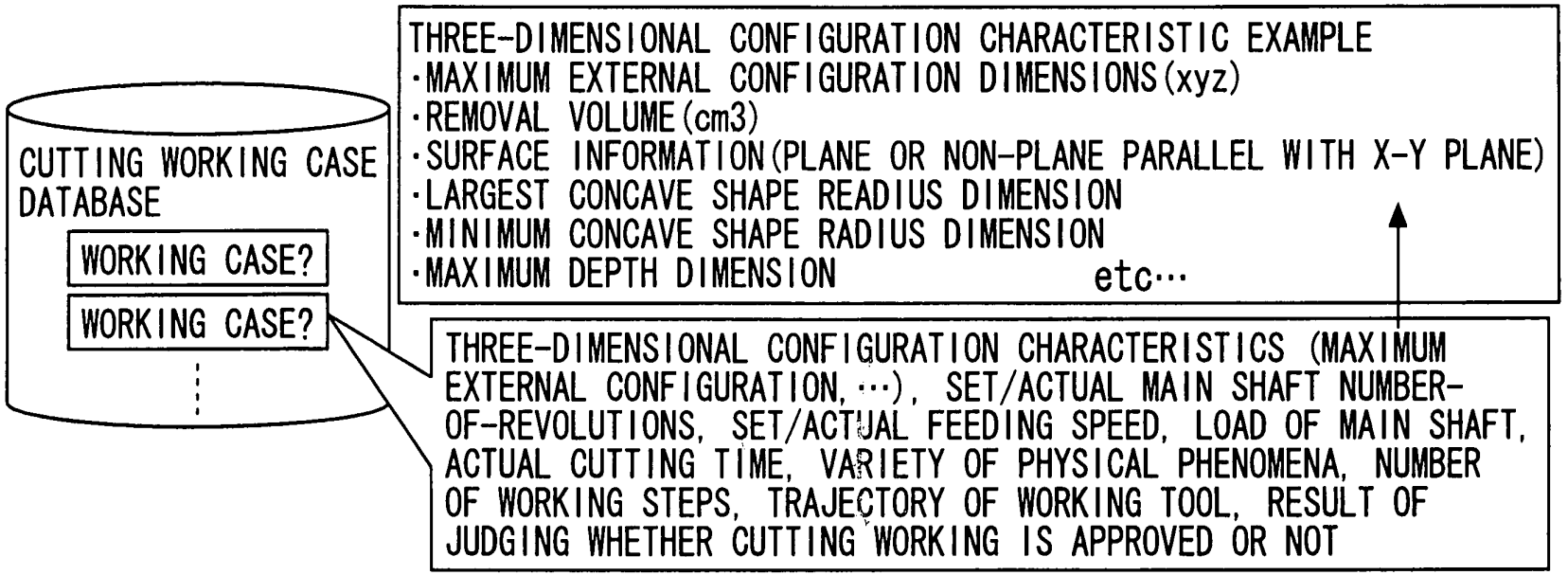

BLANK EXTERNAL CONFIGURATION
(WORK MATERIAL EXTERNAL CONFIGURATION)
Z
Y
X
MODEL MAXIMUM EXTERNAL CONFIGURATION
CUTTING WIDTH ADDED BASED ON PAST CASES

FIG. 20



<EXAMPLE OF INTERNAL DATA>

NAME OF CASE	WORKING STEP	MAXIMUM EXTERNAL CONFIGURATION DIMENSIONS	SURFACE INFORMATION	…	NUMBER OF REVOLUTIONS OF MAIN SHAFT	CUTTING FEED	TOOL USED	…	AVERAGE LOAD ON MAIN SHAFT	ACTUAL CUTTING TIME
CELLULAR PHONE	ROUGH WORKING	80×100×35	PLANE RATIO :55%	…	15000	2000	BALL φ10	…	35%	38min
NOTEBOOK PC	FINISHING1	180×280×25	PLANE RATIO :80%	…	18500	18000	BALL φ6	…	18%	70min
…										
…										
…										
…										

FIG. 21

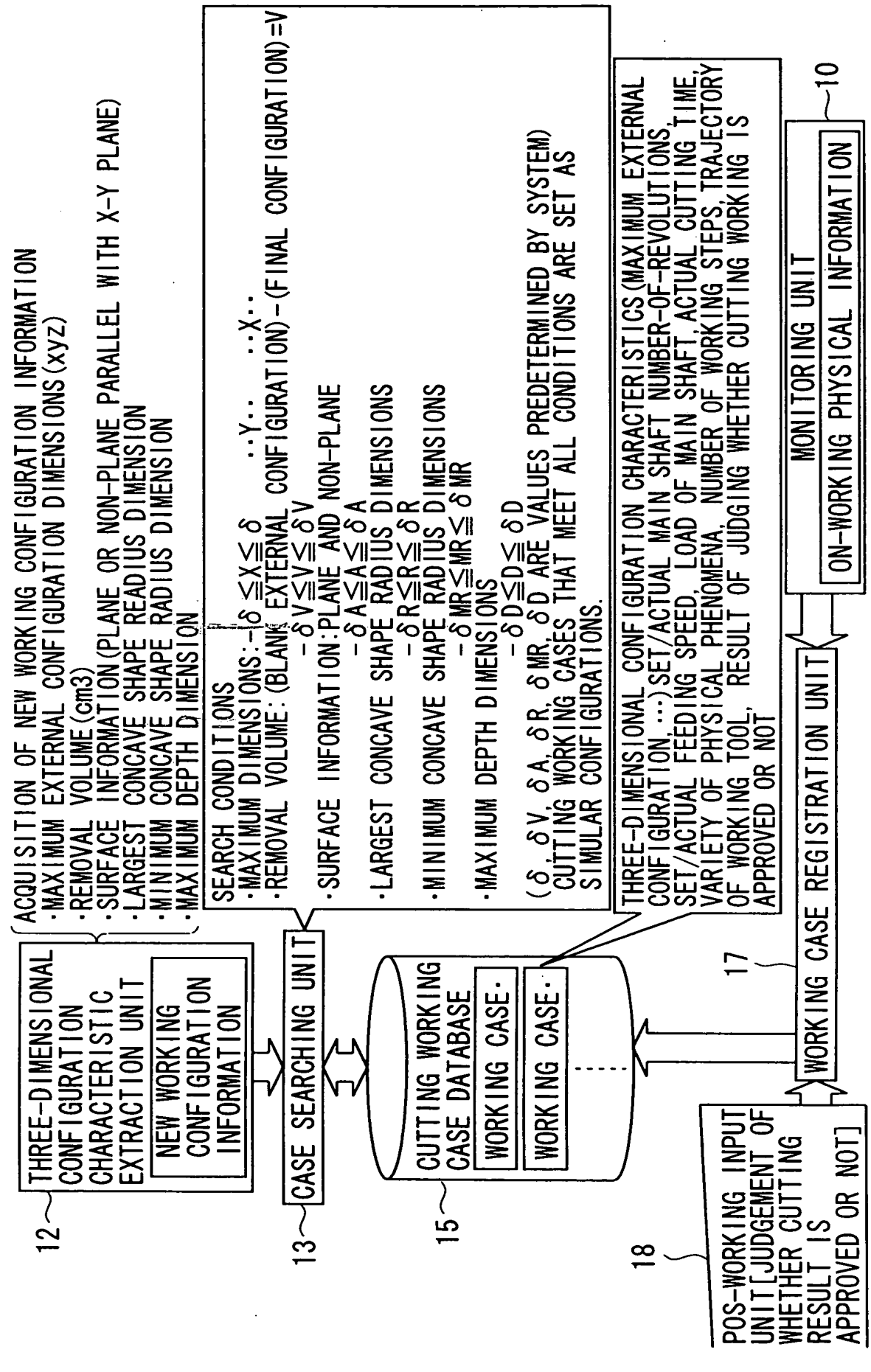
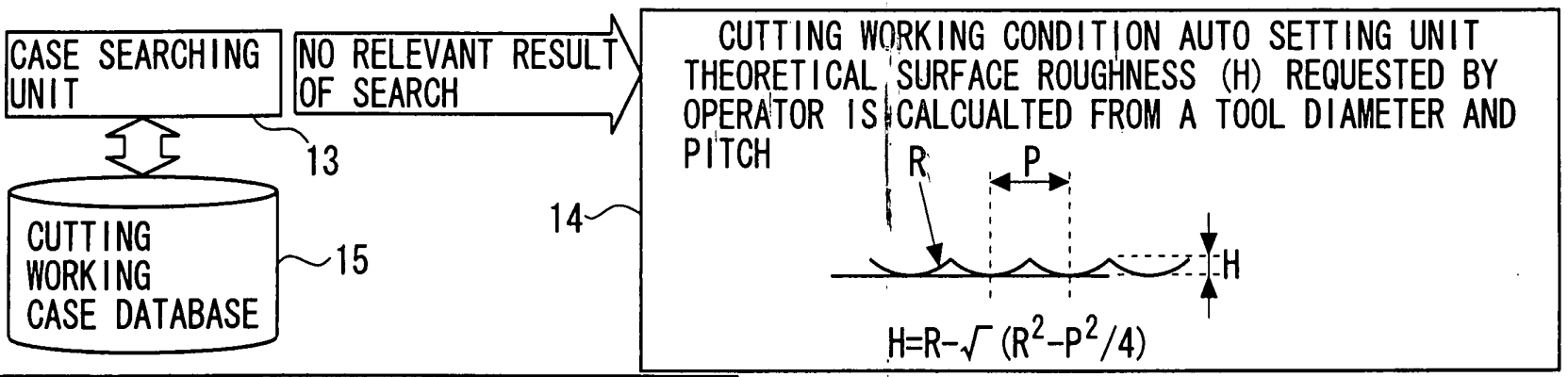

ACQUISITION OF NEW WORKING CONFIGURATION INFORMATION
·MAXIMUM EXTERNAL CONFIGURATION DIMENSIONS(xyz)
·REMOVAL VOLUME(cm3)
·SURFACE INFORMATION(PLANE OR NON-PLANE PARALLEL WITH X-Y PLANE)
·LARGEST CONCAVE SHAPE READIUS DIMENSION
·MINIMUM CONCAVE SHAPE RADIUS DIMENSION
·MAXIMUM DEPTH DIMENSION
THREE-DIMENSIONAL CONFIGURATION CHARACTERISTIC EXTRACTION UNIT
NEW WORKING CONFIGURATION INFORMATION
12
SEARCH CONDITIONS
·MAXIMUM DIMENSIONS:-δ ≦X≦ δ ..Y.. ..X..
·REMOVAL VOLUME: (BLANK EXTERNAL CONFIGURATION)-(FINAL CONFIGURATION)=V
-δV≦V≦δV
·SURFACE INFORMATION:PLANE AND NON-PLANE
-δA≦A≦δA
·LARGEST CONCAVE SHAPE RADIUS DIMENSIONS
-δR≦R≦δR
·MINIMUM CONCAVE SHAPE RADIUS DIMENSIONS
-δMR≦MR≦δMR
·MAXIMUM DEPTH DIMENSIONS
-δD≦D≦δD
(δ, δV, δA, δR, δMR, δD ARE VALUES PREDETERMINED BY SYSTEM)
CUTTING WORKING CASES THAT MEET ALL CONDITIONS ARE SET AS SIMULAR CONFIGURATIONS.
CASE SEARCHING UNIT
13
THREE-DIMENSIONAL CONFIGURATION CHARACTERISTICS(MAXIMUM EXTERNAL CONFIGURATION, ...)SET/ACTUAL MAIN SHAFT NUMBER-OF-REVOLUTIONS, SET/ACTUAL FEEDING SPEED, LOAD OF MAIN SHAFT, ACTUAL CUTTING TIME, VARIETY OF PHYSICAL PHENOMENA, NUMBER OF WORKING STEPS, TRAJECTORY OF WORKING TOOL, RESULT OF JUDGING WHETHER CUTTING WORKING IS APPROVED OR NOT
CUTTING WORKING CASE DATABASE
WORKING CASE·
WORKING CASE·
15
17
WORKING CASE REGISTRATION UNIT
MONITORING UNIT
ON-WORKING PHYSICAL INFORMATION
10
POS-WORKING INPUT UNIT[JUDGEMENT OF WHETHER CUTTING RESULT IS APPROVED OR NOT]
18

FIG. 22



SEARCH FOR CASES IN WHICH
δAmin = Hn = ARn = δAmax.
*δAmin AND δAmax ARE NUMERICAL VALUES TAKING ACCOUNT FOR ALLOWABLE VALUE TO THEORETICAL SURFACE ROUGHNESS CALCUALTED

SEARCH

OUTPUT OF RESULT

16a

WORKING CODITION THRESHOLD VALUE DATABASE

	WORK MATERIAL	TOOL USED	NUMBER OF REVOLUTIONS	FEED	PITCH	WORKING SURFACE ROUGHNESS (THEORETICAL VALUE)	WORKING SURFACE ROUGHNESS (ACTUALLY MEASURED AVERAGE VALUE)
THRESHOLD VALUE A	AI	φ10 BALL	12000	1000	0.1	0.001	0.004
THRESHOLD VALUE B	NAK	φ6 BALL	18000	1800	0.15	0.002	0.005
.....							
.....							

FOR INSTNACE, IF 0.004 IS SET AS TARGET OF WORKING SURFACE ROUGHNESS, AND WHEN WORK MATERIAL IS AI, CONDITIONS FOR THRESHOLD VALUE B ARE USED

*WORKING SURFACE ROUGHNESS HAS ERROR BETWEEN THEORETICAL VALUE AND ACTUALLY MEASURED VALUE. ACTUALLY MEASURED VALUE TENDS TO BE ROUGHER THAN THEORETICAL VALUE.

FIG. 23

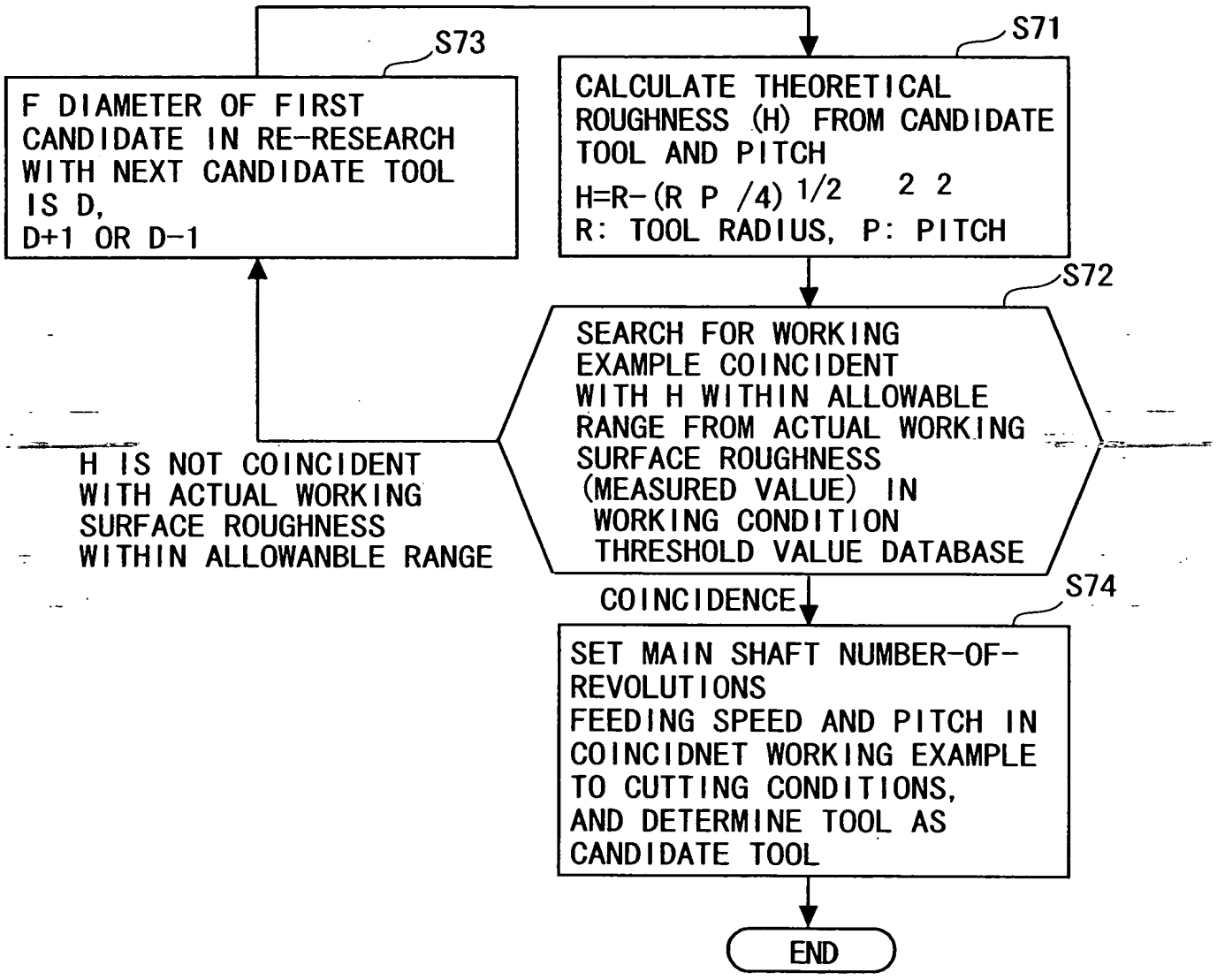

S71
CALCULATE THEORETICAL ROUGHNESS (H) FROM CANDIDATE TOOL AND PITCH
H=R-(R P /4) 1/2 2 2
R: TOOL RADIUS, P: PITCH
S72
SEARCH FOR WORKING EXAMPLE COINCIDENT WITH H WITHIN ALLOWABLE RANGE FROM ACTUAL WORKING SURFACE ROUGHNESS (MEASURED VALUE) IN WORKING CONDITION THRESHOLD VALUE DATABASE
COINCIDENCE
S74
SET MAIN SHAFT NUMBER-OF-REVOLUTIONS FEEDING SPEED AND PITCH IN COINCIDNET WORKING EXAMPLE TO CUTTING CONDITIONS, AND DETERMINE TOOL AS CANDIDATE TOOL
END
H IS NOT COINCIDENT WITH ACTUAL WORKING SURFACE ROUGHNESS WITHIN ALLOWANBLE RANGE
S73
F DIAMETER OF FIRST CANDIDATE IN RE-RESEARCH WITH NEXT CANDIDATE TOOL IS D,
D+1 OR D-1

FIG. 24

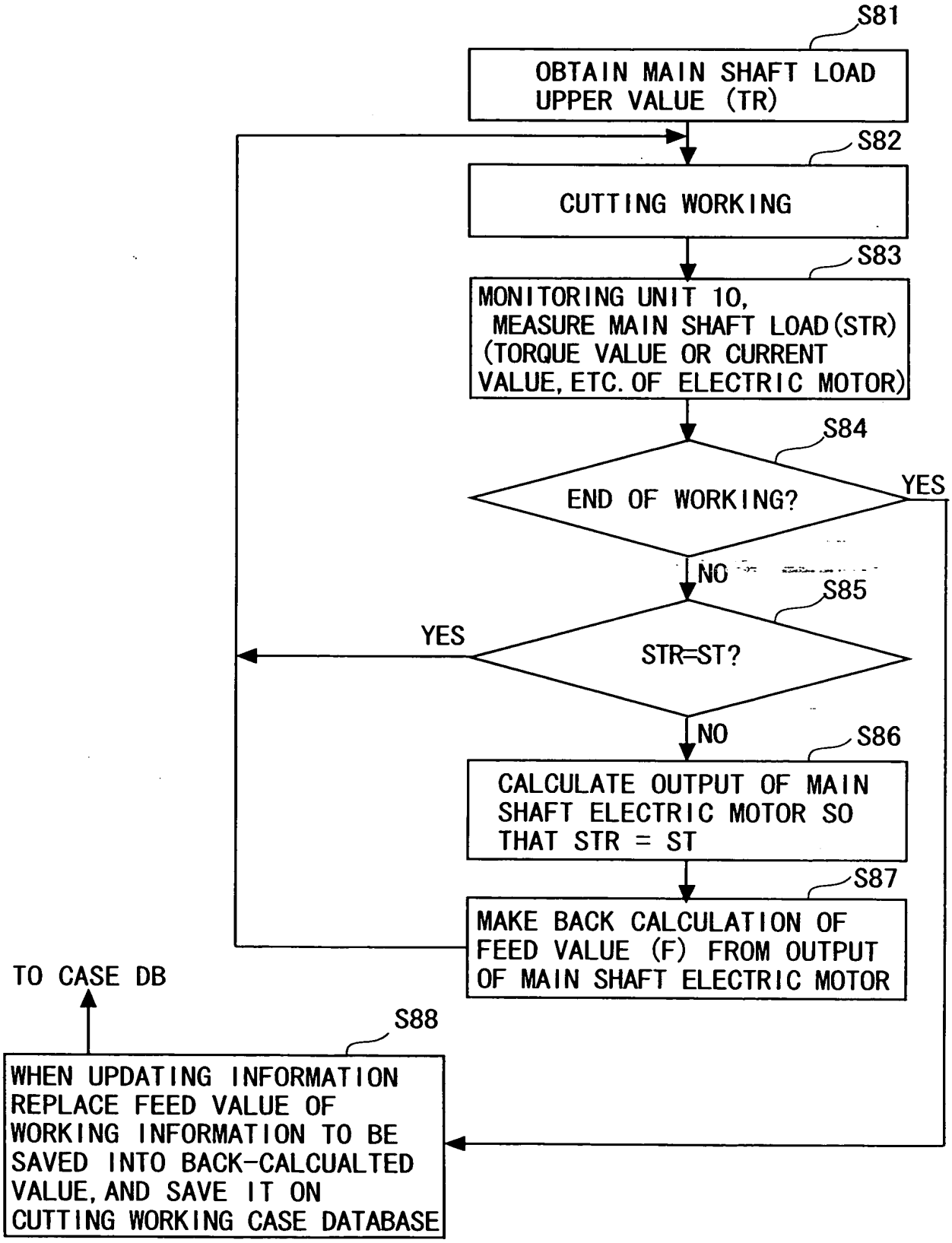
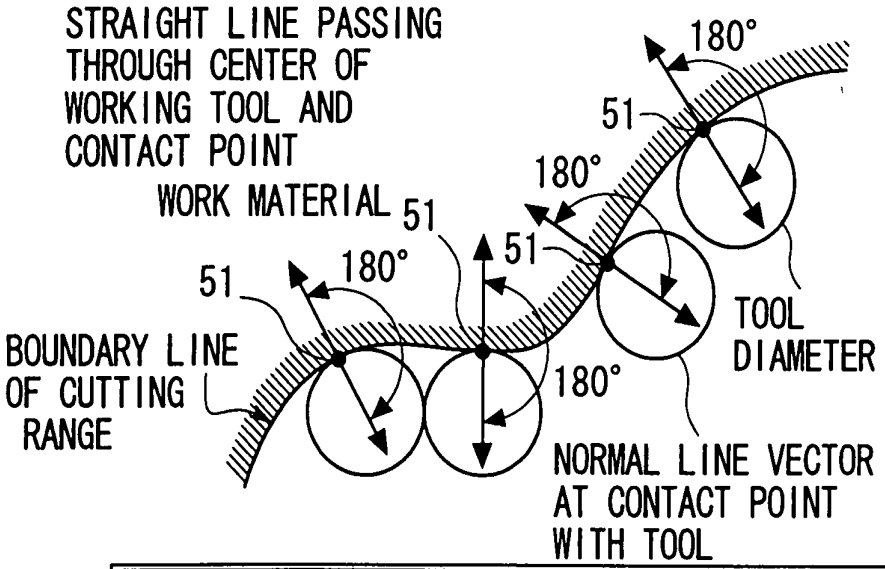

S81
OBTAIN MAIN SHAFT LOAD UPPER VALUE (TR)
S82
CUTTING WORKING
S83
MONITORING UNIT 10, MEASURE MAIN SHAFT LOAD (STR) (TORQUE VALUE OR CURRENT VALUE, ETC. OF ELECTRIC MOTOR)
S84
END OF WORKING?
YES
NO
S85
STR=ST?
YES
NO
S86
CALCULATE OUTPUT OF MAIN SHAFT ELECTRIC MOTOR SO THAT STR = ST
S87
MAKE BACK CALCULATION OF FEED VALUE (F) FROM OUTPUT OF MAIN SHAFT ELECTRIC MOTOR
TO CASE DB
S88
WHEN UPDATING INFORMATION REPLACE FEED VALUE OF WORKING INFORMATION TO BE SAVED INTO BACK-CALCUALTED VALUE, AND SAVE IT ON CUTTING WORKING CASE DATABASE

FIG. 25A

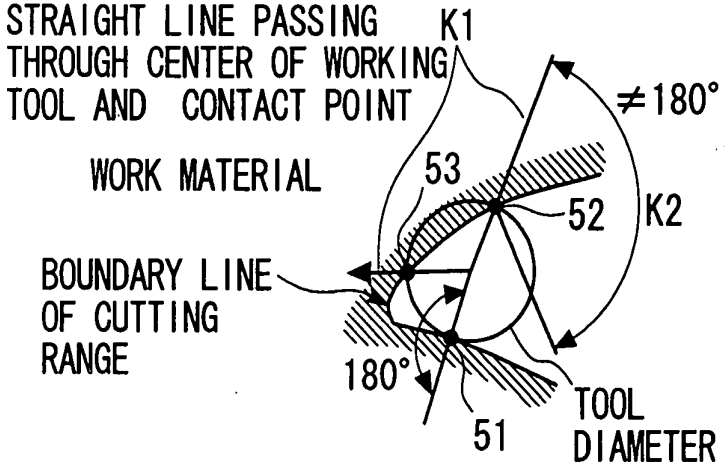
WHEN NORMAL LINE VECTOR AT CONTACT POINT WITH WORKING TOOL AND STRAIGHT LINE PASSING THROUGH CENTER OF WORKING TOOL AND CONTACT POINT ALWAYS MAKE 180°



IN CASE CONDITIONS ARE MET AT ALL CONTACT POINTS, IT IS JUDGED THAT THERE IS NO INTERFERENCE BETWEEN TOOL AND CUTTING BOUNDARY, AND TOOL DIAMETER IS USABLE

FIG. 25B

WHEN NORMAL LINE VECTOR AT CONTACT POINT WITH WORKING TOOL AND STRAIGHT LINE PASSING THROUGH CENTER OF WORKING TOOL AND CONTACT POINT DO NOT MAKE 180°



IN CASE CONDITIONS ARE NOT MET AT ALL CONTACT POINTS, IT IS JUDGED THAT THERE IS INTERFERENCE BETWEEN TOOL AND CUTTING BOUNDARY, AND TOOL DIAMETER IS UNUSABLE

SEARCH-OUT IS REPEATED TILL CONDITIONS ARE MET, AND SELECT TOOL DIAMETER CAUSING NO INTERFERNECE

FIG. 26

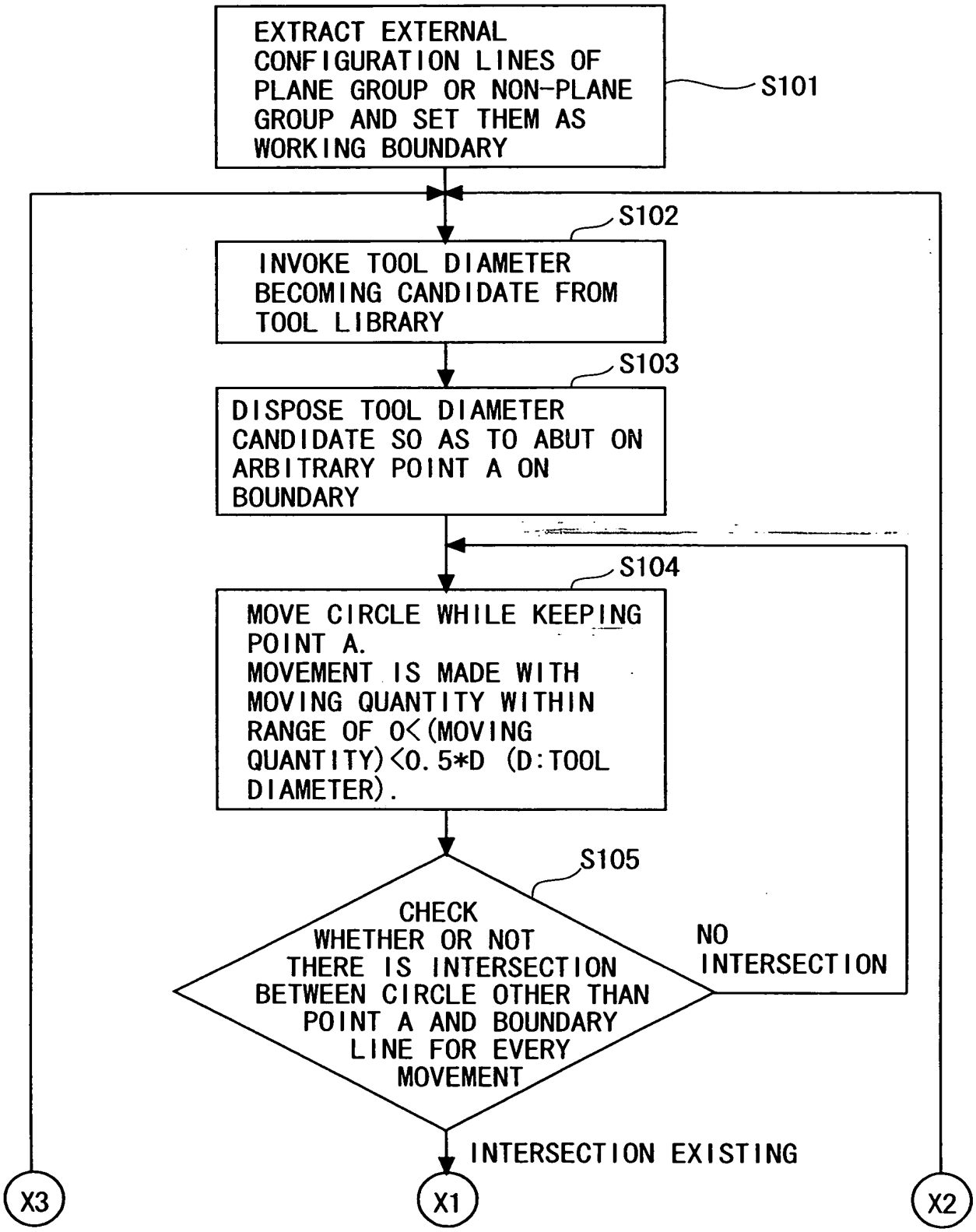

EXTRACT EXTERNAL CONFIGURATION LINES OF PLANE GROUP OR NON-PLANE GROUP AND SET THEM AS WORKING BOUNDARY
S101
S102
INVOKE TOOL DIAMETER BECOMING CANDIDATE FROM TOOL LIBRARY
S103
DISPOSE TOOL DIAMETER CANDIDATE SO AS TO ABUT ON ARBITRARY POINT A ON BOUNDARY
S104
MOVE CIRCLE WHILE KEEPING POINT A. MOVEMENT IS MADE WITH MOVING QUANTITY WITHIN RANGE OF 0<(MOVING QUANTITY)<0.5*D (D:TOOL DIAMETER).
S105
CHECK WHETHER OR NOT THERE IS INTERSECTION BETWEEN CIRCLE OTHER THAN POINT A AND BOUNDARY LINE FOR EVERY MOVEMENT
NO INTERSECTION
INTERSECTION EXISTING
X3
X1
X2

FIG. 27

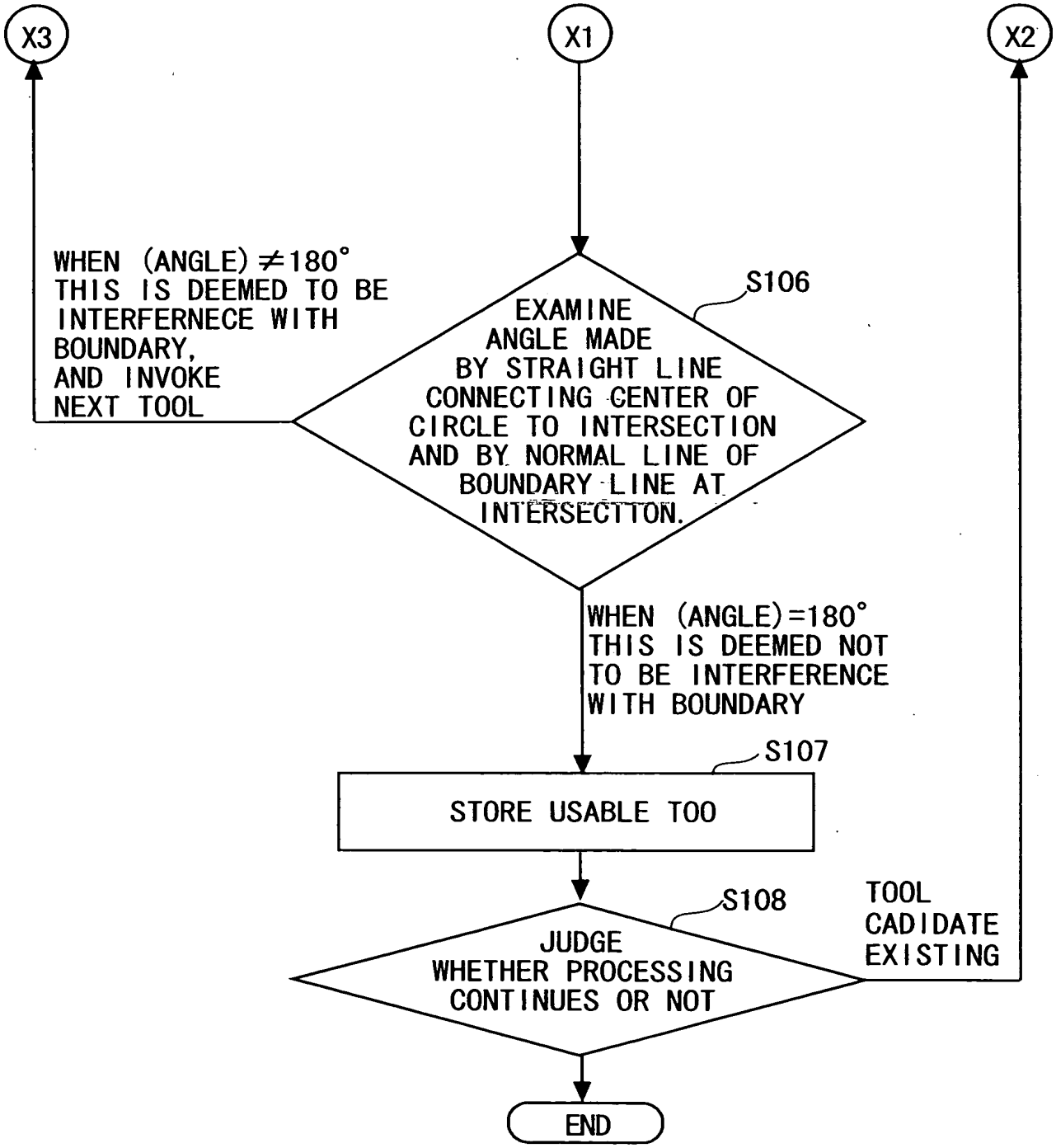

X3
X1
X2
WHEN (ANGLE)≠180° THIS IS DEEMED TO BE INTERFERNECE WITH BOUNDARY, AND INVOKE NEXT TOOL
S106
EXAMINE ANGLE MADE BY STRAIGHT LINE CONNECTING CENTER OF CIRCLE TO INTERSECTION AND BY NORMAL LINE OF BOUNDARY LINE AT INTERSECTION.
WHEN (ANGLE)=180° THIS IS DEEMED NOT TO BE INTERFERENCE WITH BOUNDARY
S107
STORE USABLE TOO
S108
JUDGE WHETHER PROCESSING CONTINUES OR NOT
TOOL CADIDATE EXISTING
END

FIG. 28

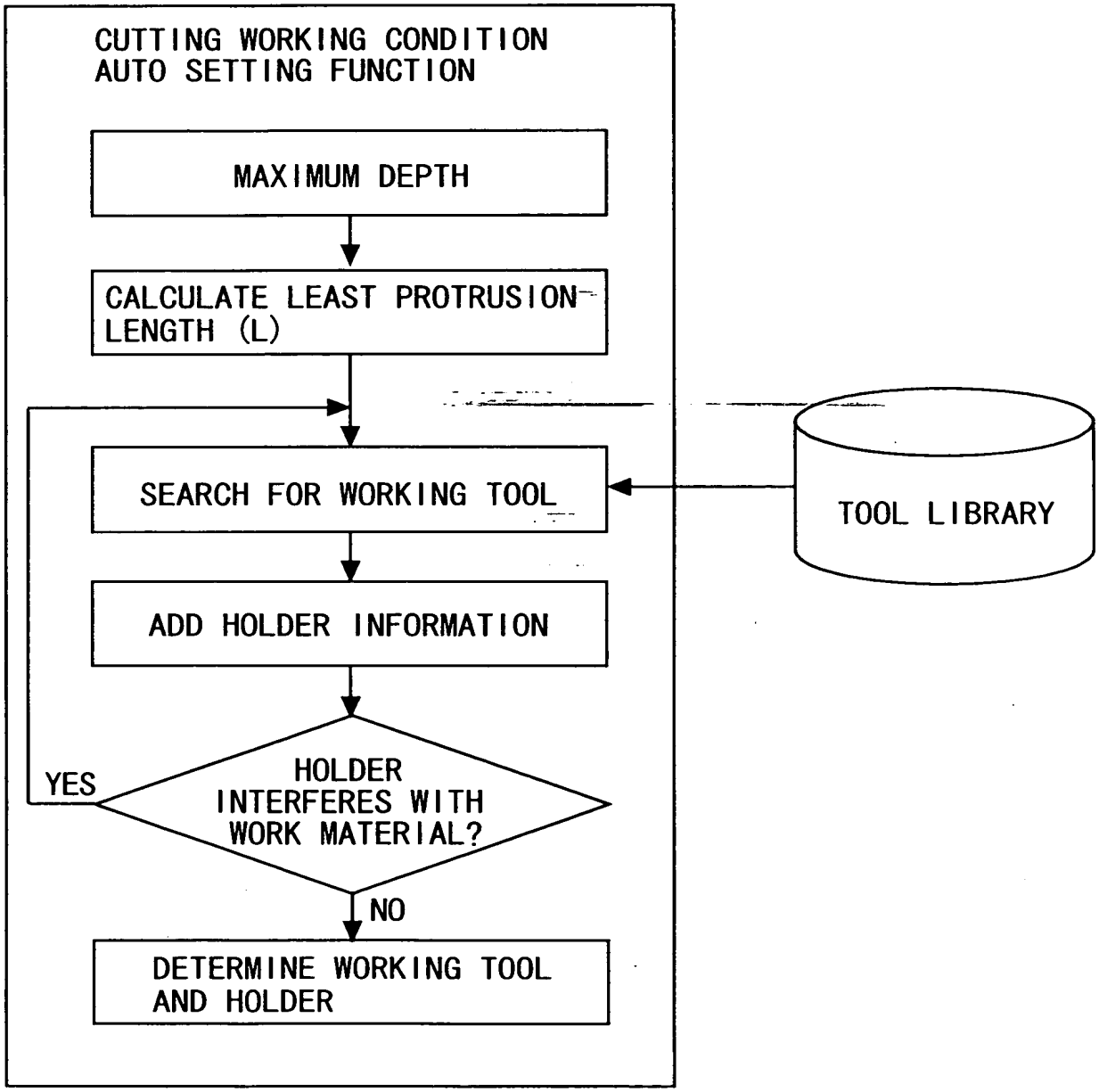

CUTTING WORKING CONDITION AUTO SETTING FUNCTION
MAXIMUM DEPTH
CALCULATE LEAST PROTRUSION LENGTH (L)
SEARCH FOR WORKING TOOL
TOOL LIBRARY
ADD HOLDER INFORMATION
YES
HOLDER INTERFERES WITH WORK MATERIAL?
NO
DETERMINE WORKING TOOL AND HOLDER

FIG. 29

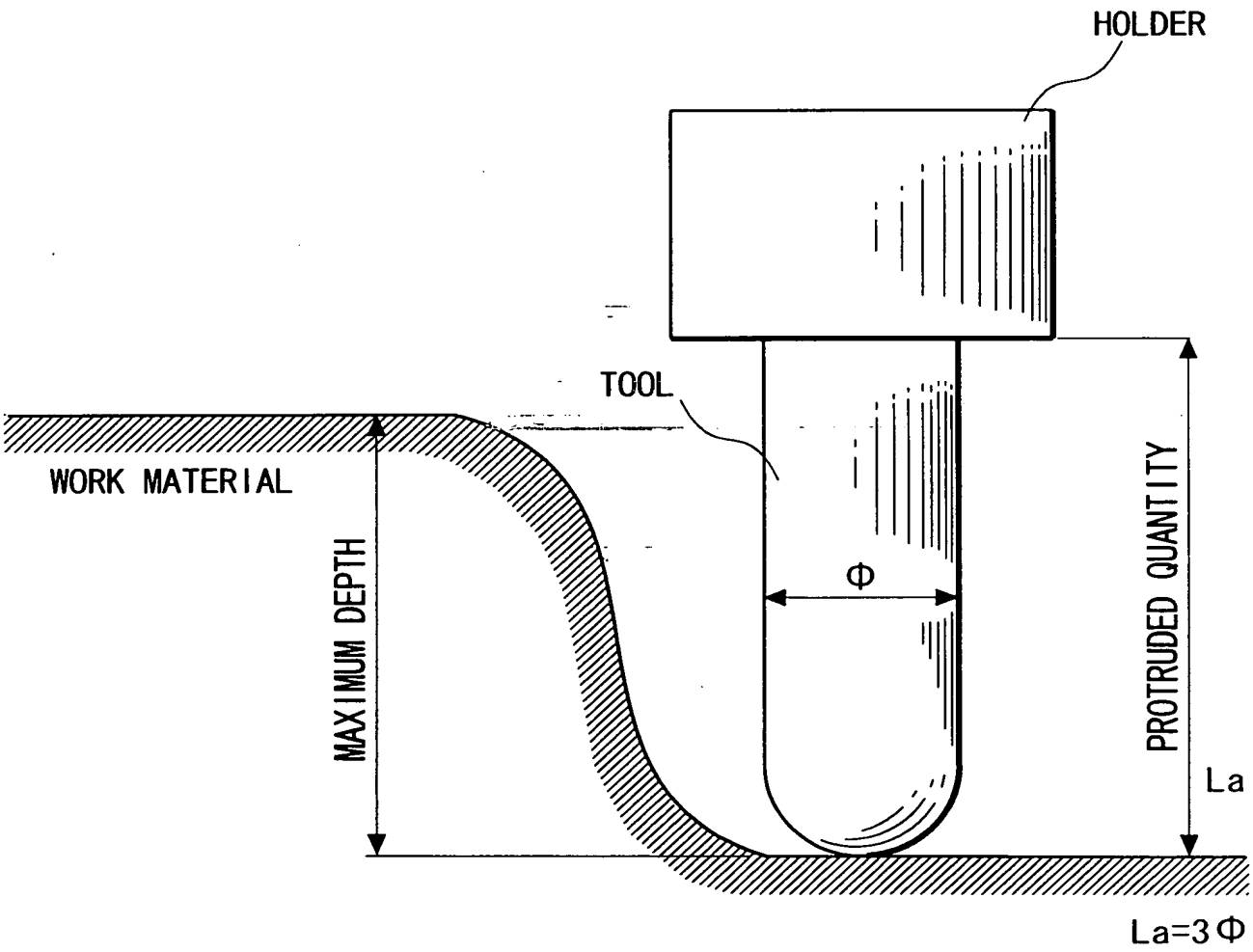
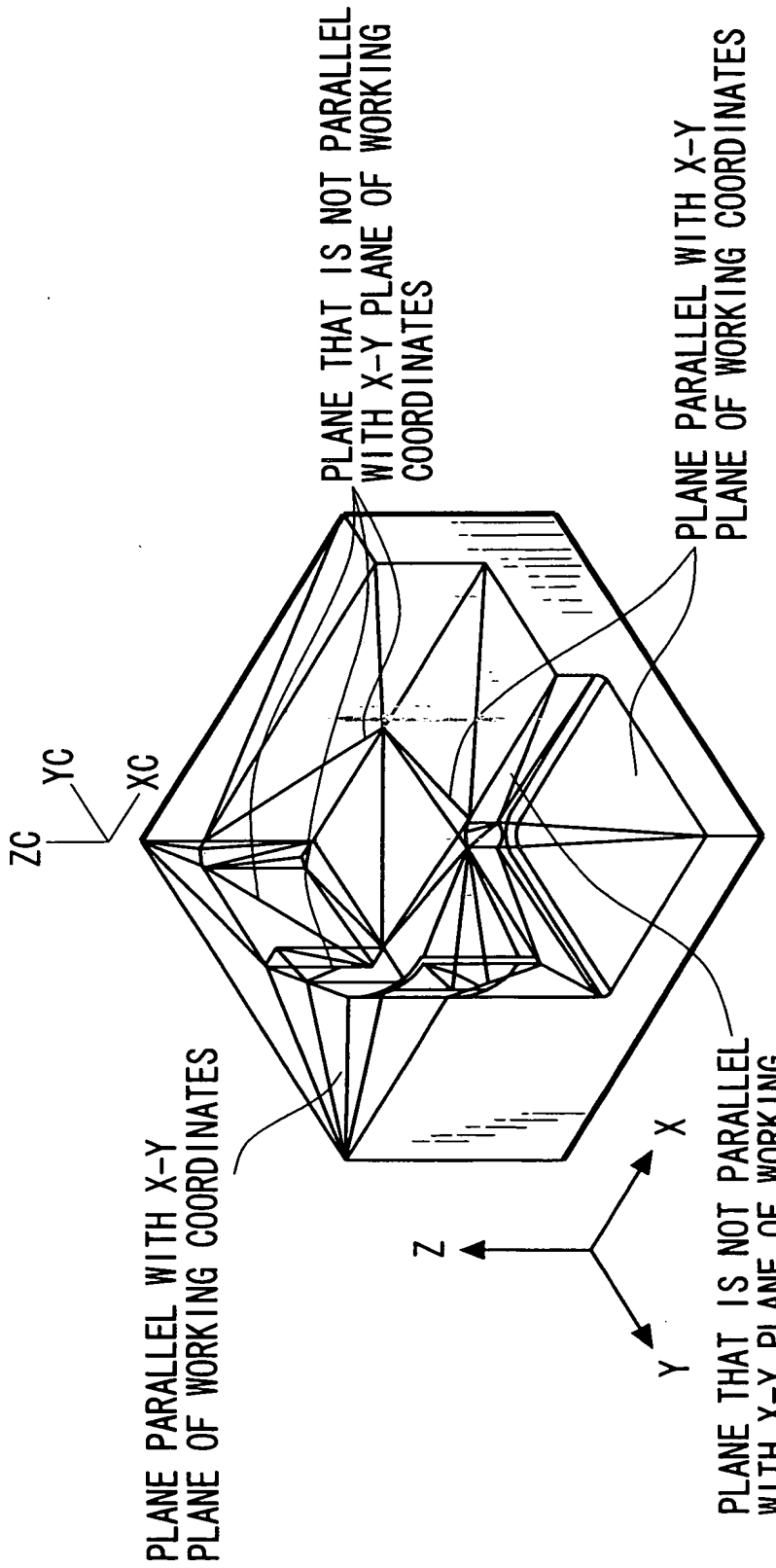

HOLDER
TOOL
WORK MATERIAL
MAXIMUM DEPTH
Φ
PROTRUDED QUANTITY
La
La=3Φ

FIG. 30



[TARGET SURFACE] : SURFACE AS VIEWED IN WORKING COORDINATES + Z-DIRECTION
- DISTINGUISH BETWEEN PLANE AND NON-PLANE.
- PLANE PORTION IS ASSIGNED FLAT END MILL OR BULLNOSE AS WORKING TOOL.
- NON-PLANE PORTION IS ASSIGNED BALL END MILL AS WORKING TOOL.

FIG. 31

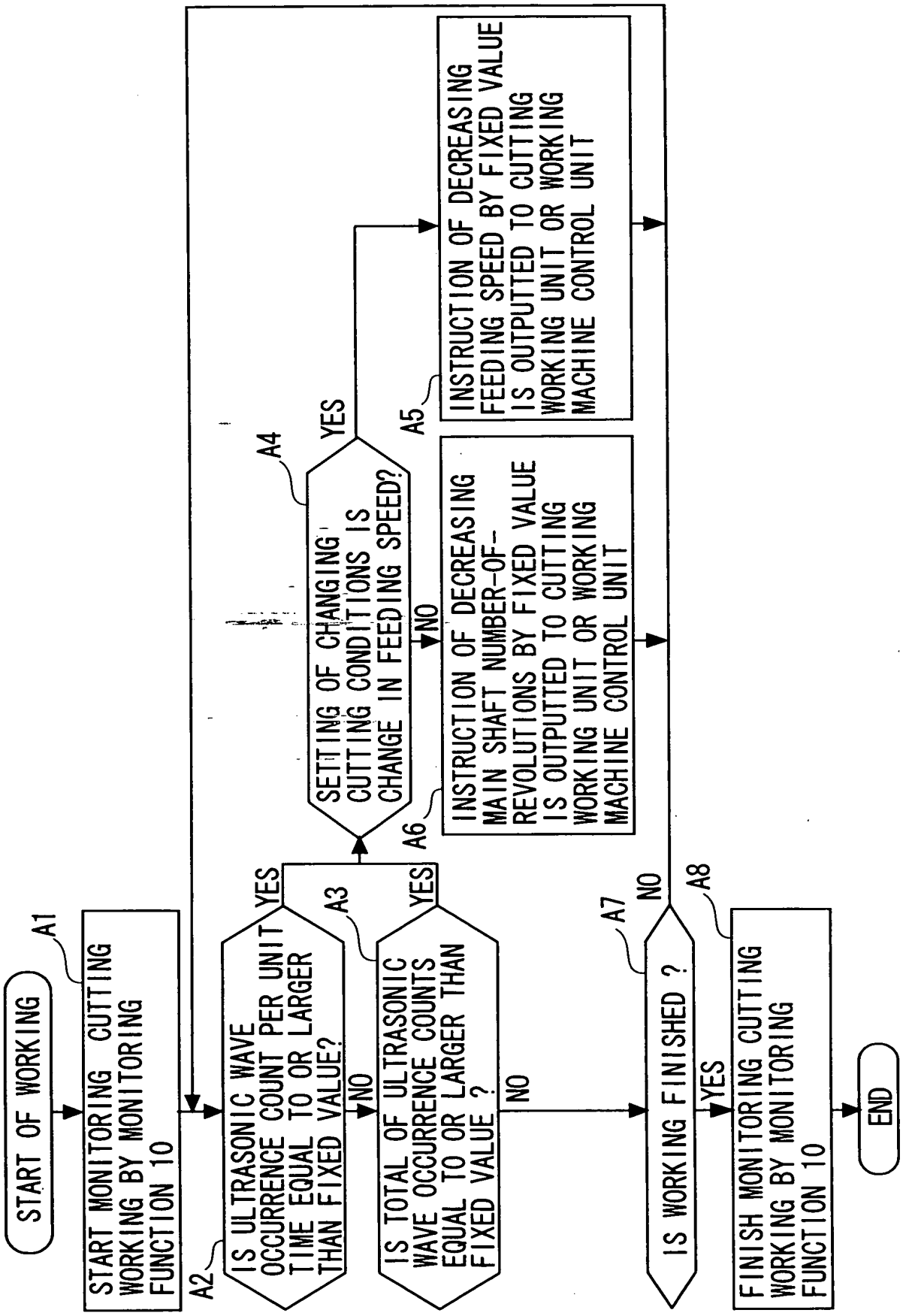

START OF WORKING
A1
START MONITORING CUTTING WORKING BY MONITORING FUNCTION 10
A2
IS ULTRASONIC WAVE OCCURRENCE COUNT PER UNIT TIME EQUAL TO OR LARGER THAN FIXED VALUE?
YES
NO
A3
IS TOTAL OF ULTRASONIC WAVE OCCURRENCE COUNTS EQUAL TO OR LARGER THAN FIXED VALUE ?
YES
NO
A4
SETTING OF CHANGING CUTTING CONDITIONS IS CHANGE IN FEEDING SPEED?
YES
NO
A5
INSTRUCTION OF DECREASING FEEDING SPEED BY FIXED VALUE IS OUTPUTTED TO CUTTING WORKING UNIT OR WORKING MACHINE CONTROL UNIT
A6
INSTRUCTION OF DECREASING MAIN SHAFT NUMBER-OF-REVOLUTIONS BY FIXED VALUE IS OUTPUTTED TO CUTTING WORKING UNIT OR WORKING MACHINE CONTROL UNIT
A7
IS WORKING FINISHED ?
NO
YES
A8
FINISH MONITORING CUTTING WORKING BY MONITORING FUNCTION 10
END

FIG. 32

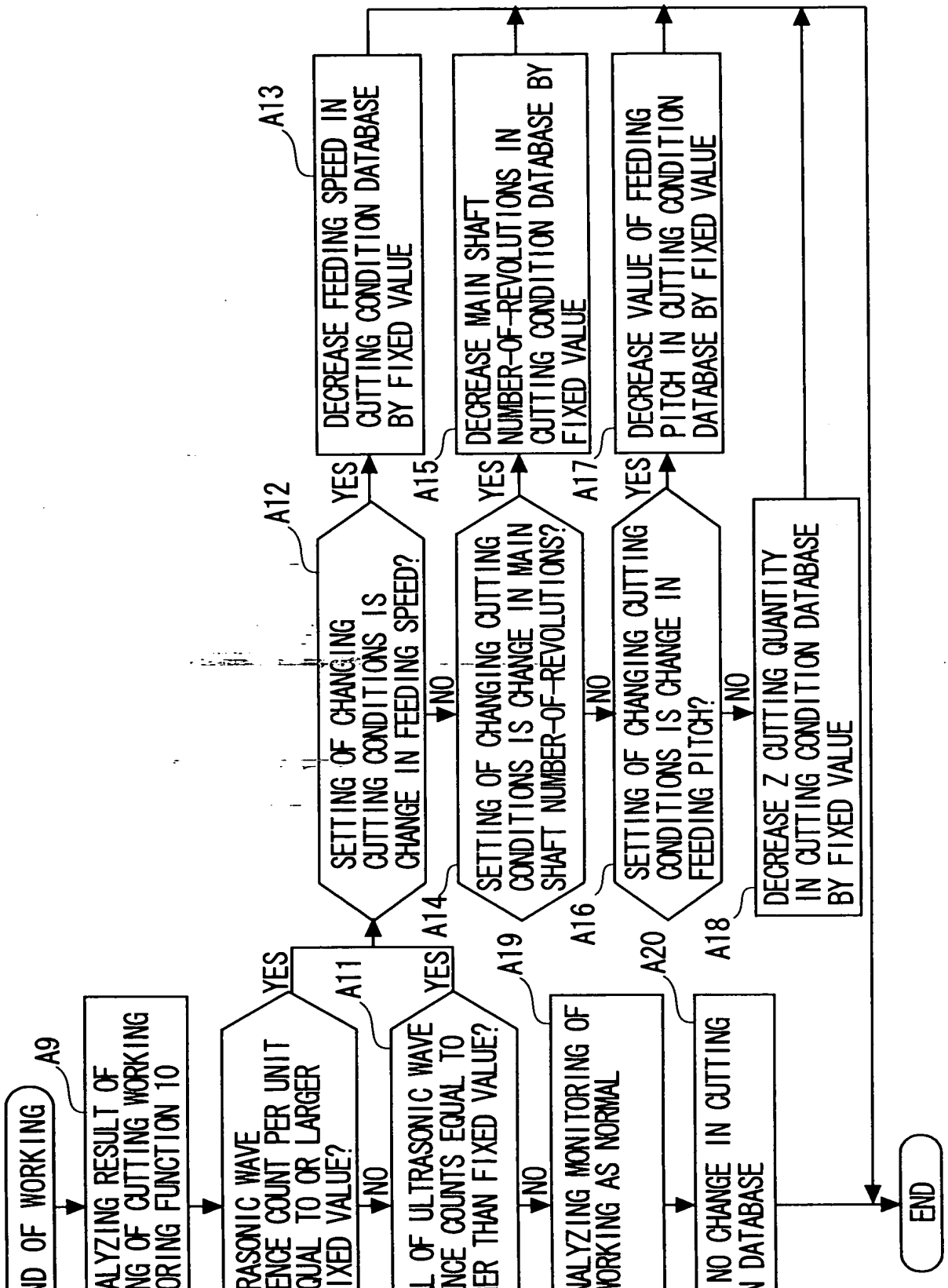

END OF WORKING
A9
START ANALYZING RESULT OF MONITORING OF CUTTING WORKING BY MONITORING FUNCTION 10
A10
IS ULTRASONIC WAVE OCCURRENCE COUNT PER UNIT TIME EQUAL TO OR LARGER THAN FIXED VALUE?
YES
NO
A11
IS TOTAL OF ULTRASONIC WAVE OCCURRENCE COUNTS EQUAL TO OR LARGER THAN FIXED VALUE?
YES
NO
A12
SETTING OF CHANGING CUTTING CONDITIONS IS CHANGE IN FEEDING SPEED?
YES
NO
A13
DECREASE FEEDING SPEED IN CUTTING CONDITION DATABASE BY FIXED VALUE
A14
SETTING OF CHANGING CUTTING CONDITIONS IS CHANGE IN MAIN SHAFT NUMBER-OF-REVOLUTIONS?
YES
NO
A15
DECREASE MAIN SHAFT NUMBER-OF-REVOLUTIONS IN CUTTING CONDITION DATABASE BY FIXED VALUE
A16
SETTING OF CHANGING CUTTING CONDITIONS IS CHANGE IN FEEDING PITCH?
YES
NO
A17
DECREASE VALUE OF FEEDING PITCH IN CUTTING CONDITION DATABASE BY FIXED VALUE
A18
DECREASE Z CUTTING QUANTITY IN CUTTING CONDITION DATABASE BY FIXED VALUE
A19
FINISH ANALYZING MONITORING OF CUTTING WORKING AS NORMAL WORKING
A20
THERE IS NO CHANGE IN CUTTING CONDITION DATABASE
END

FIG. 33A

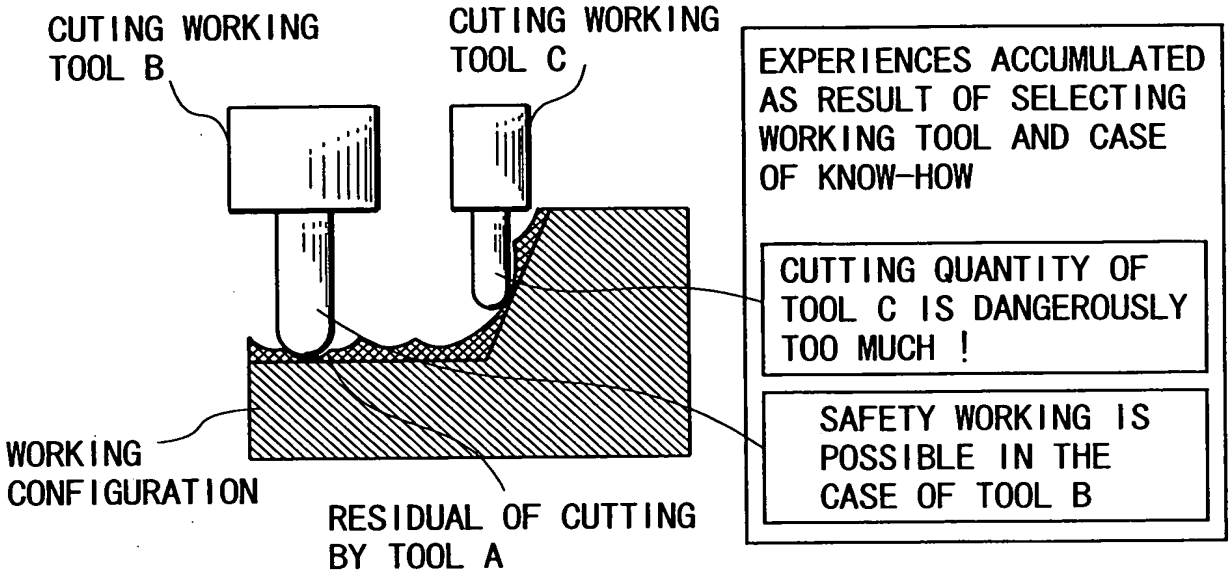


FIG. 33B

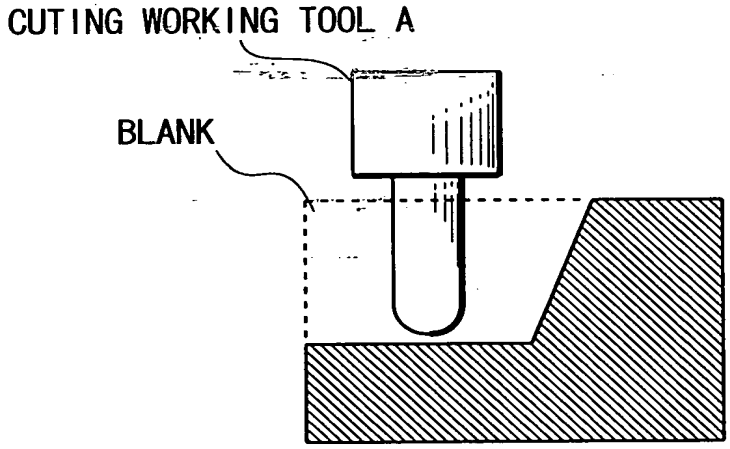


FIG. 33C

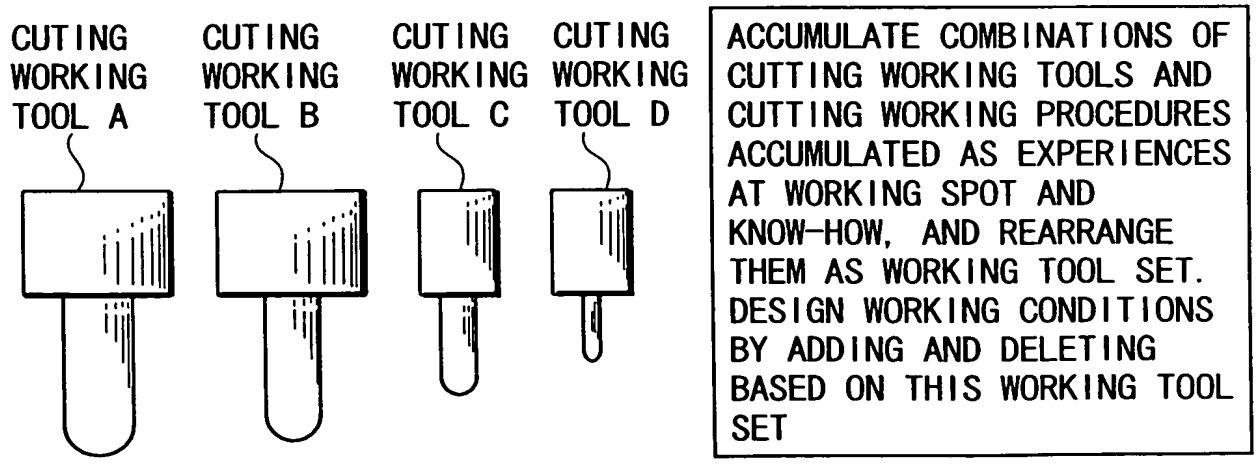


FIG. 34

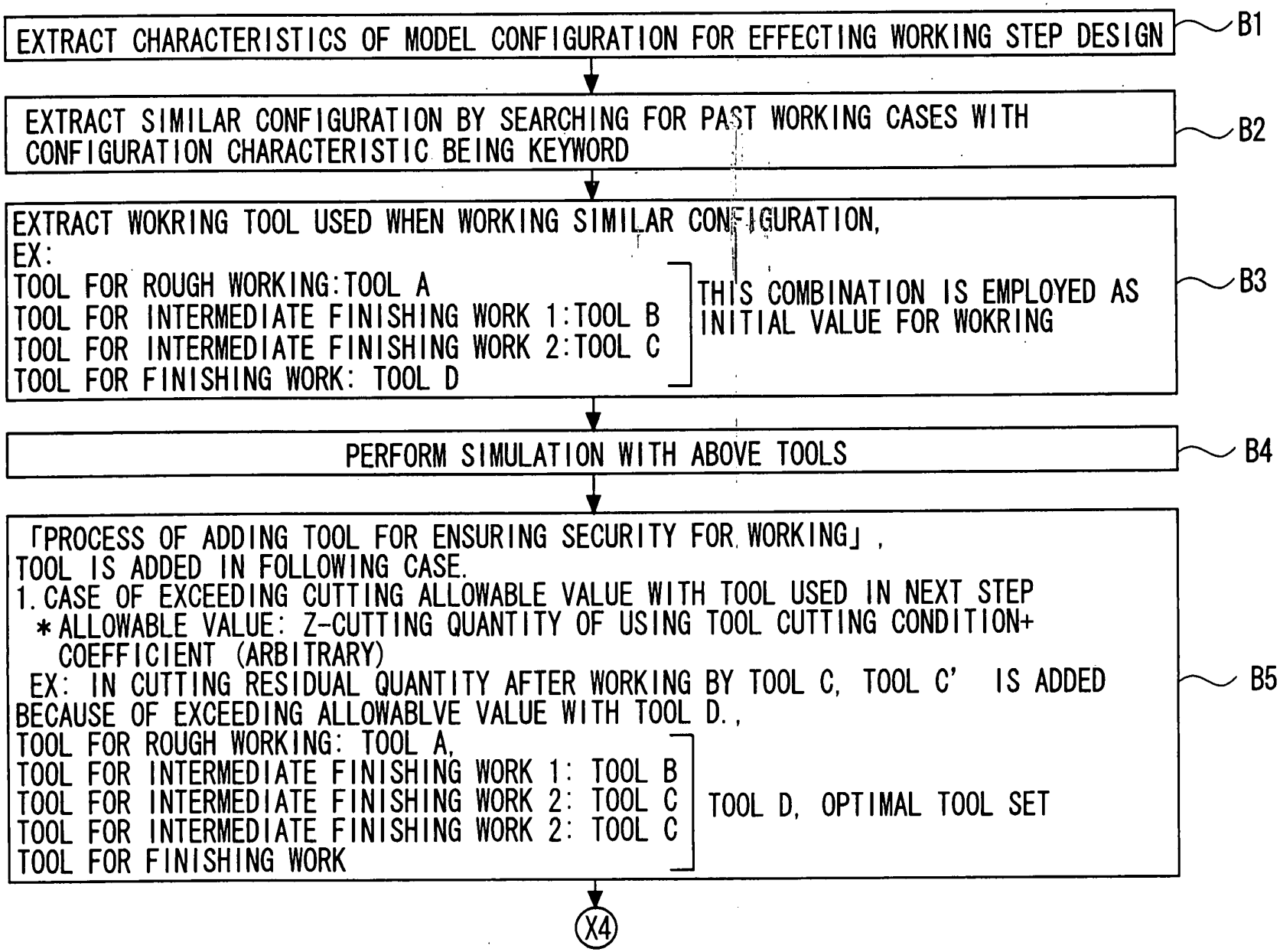


FIG. 35

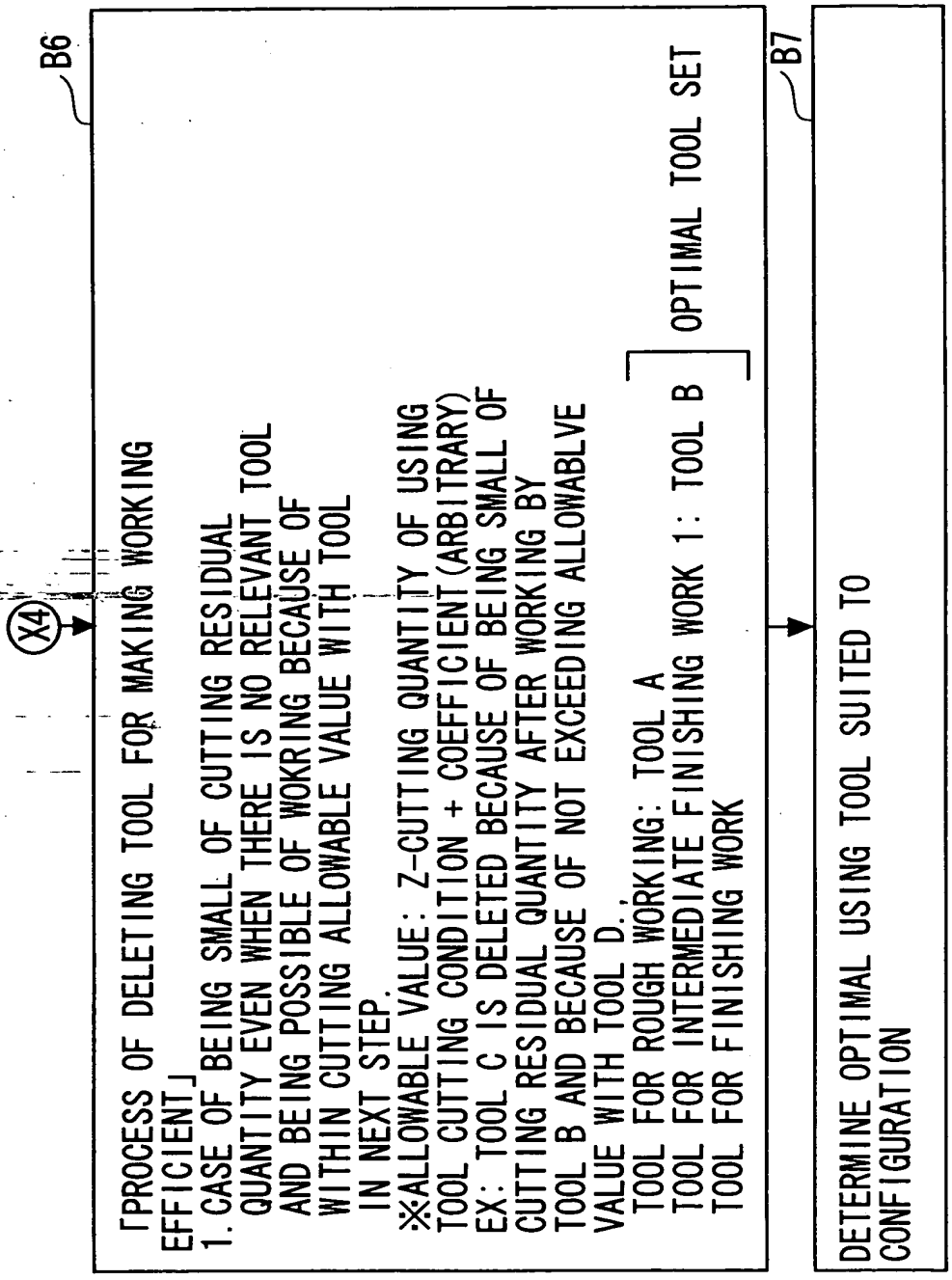

X4
B6
「PROCESS OF DELETING TOOL FOR MAKING WORKING EFFICIENT」
1. CASE OF BEING SMALL OF CUTTING RESIDUAL QUANTITY EVEN WHEN THERE IS NO RELEVANT TOOL AND BEING POSSIBLE OF WOKRING BECAUSE OF WITHIN CUTTING ALLOWABLE VALUE WITH TOOL IN NEXT STEP.
※ALLOWABLE VALUE: Z-CUTTING QUANTITY OF USING TOOL CUTTING CONDITION + COEFFICIENT(ARBITRARY)
EX: TOOL C IS DELETED BECAUSE OF BEING SMALL OF CUTTING RESIDUAL QUANTITY AFTER WORKING BY TOOL B AND BECAUSE OF NOT EXCEEDING ALLOWABLVE VALUE WITH TOOL D.,
TOOL FOR ROUGH WORKING: TOOL A
TOOL FOR INTERMEDIATE FINISHING WORK 1: TOOL B
TOOL FOR FINISHING WORK
OPTIMAL TOOL SET
B7
DETERMINE OPTIMAL USING TOOL SUITED TO CONFIGURATION

FIG. 36A

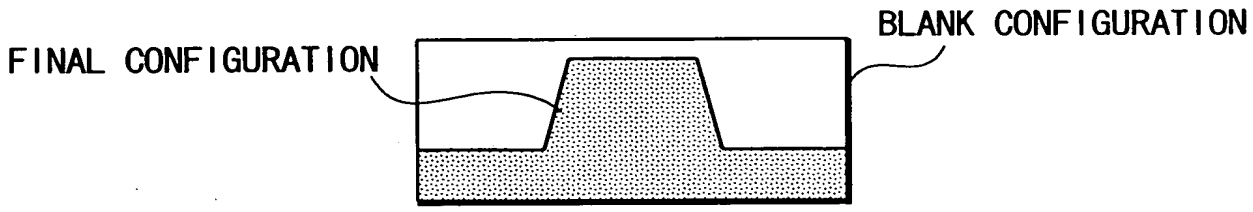


FIG. 36B

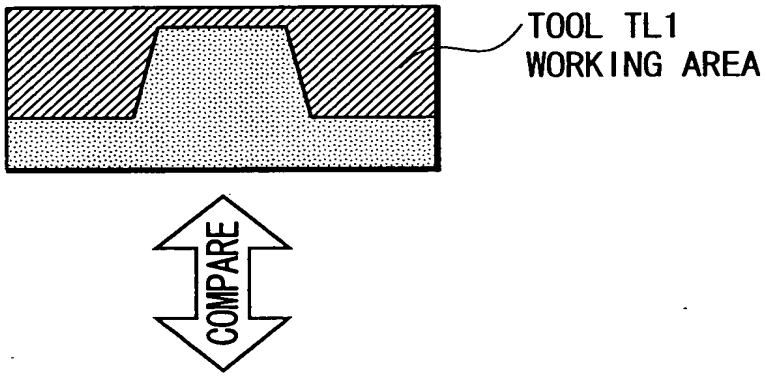


FIG. 36C

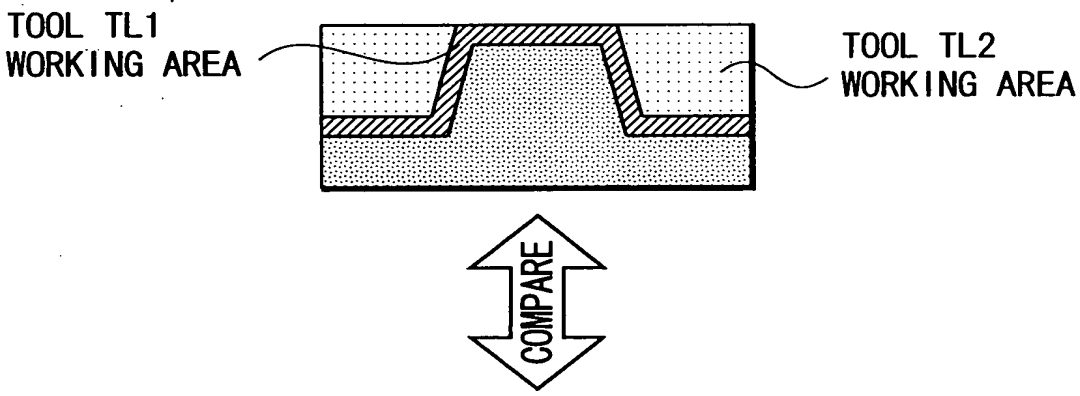


FIG. 36D

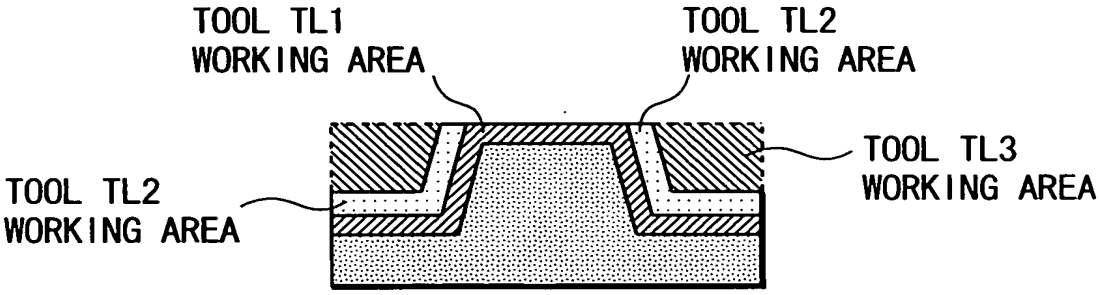


FIG. 37

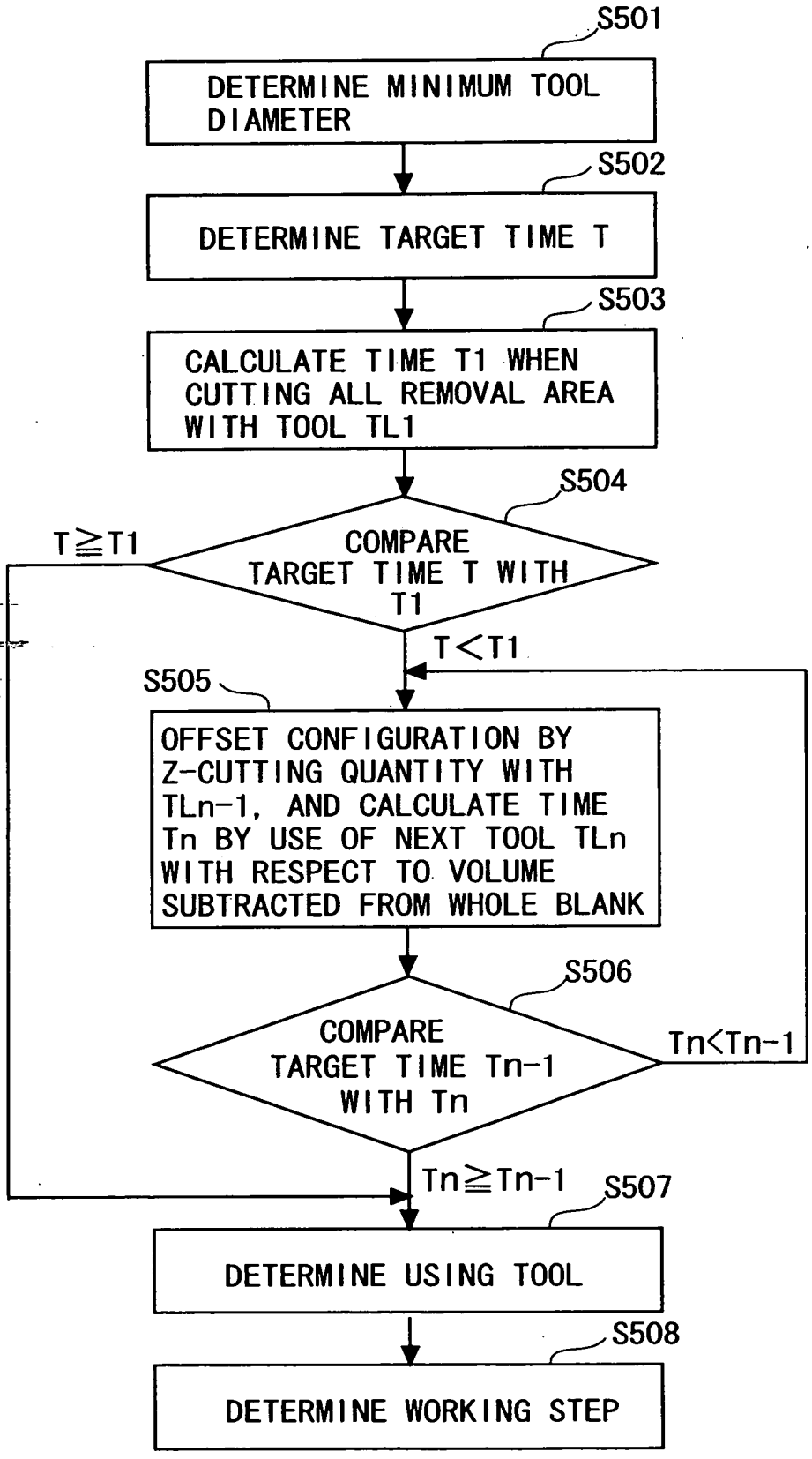

S501
DETERMINE MINIMUM TOOL DIAMETER
S502
DETERMINE TARGET TIME T
S503
CALCULATE TIME T1 WHEN CUTTING ALL REMOVAL AREA WITH TOOL TL1
S504
COMPARE TARGET TIME T WITH T1
T≧T1
T<T1
S505
OFFSET CONFIGURATION BY Z-CUTTING QUANTITY WITH TLn-1, AND CALCULATE TIME Tn BY USE OF NEXT TOOL TLn WITH RESPECT TO VOLUME SUBTRACTED FROM WHOLE BLANK
S506
COMPARE TARGET TIME Tn-1 WITH Tn
Tn<Tn-1
Tn≧Tn-1
S507
DETERMINE USING TOOL
S508
DETERMINE WORKING STEP

FIG. 38A

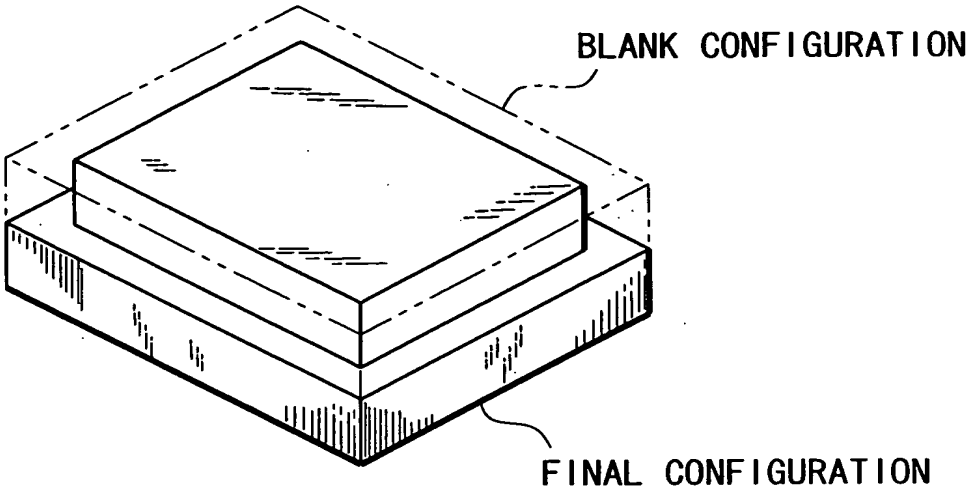


FIG. 38B

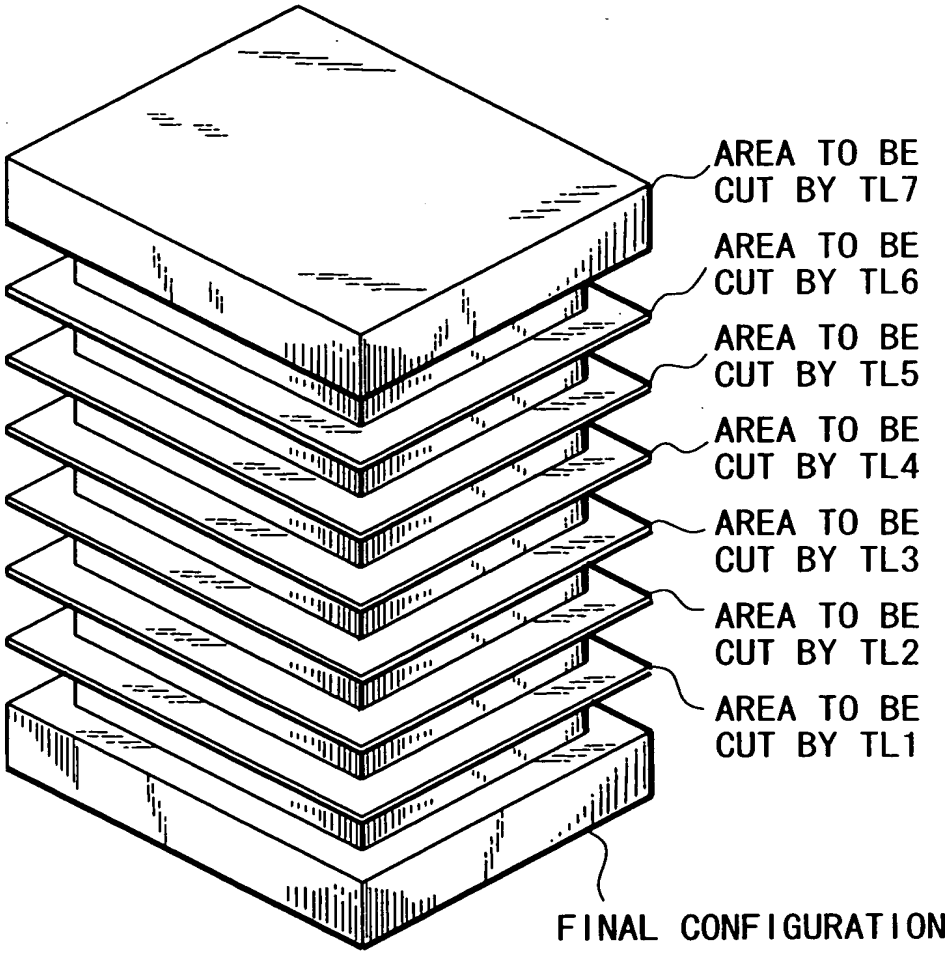
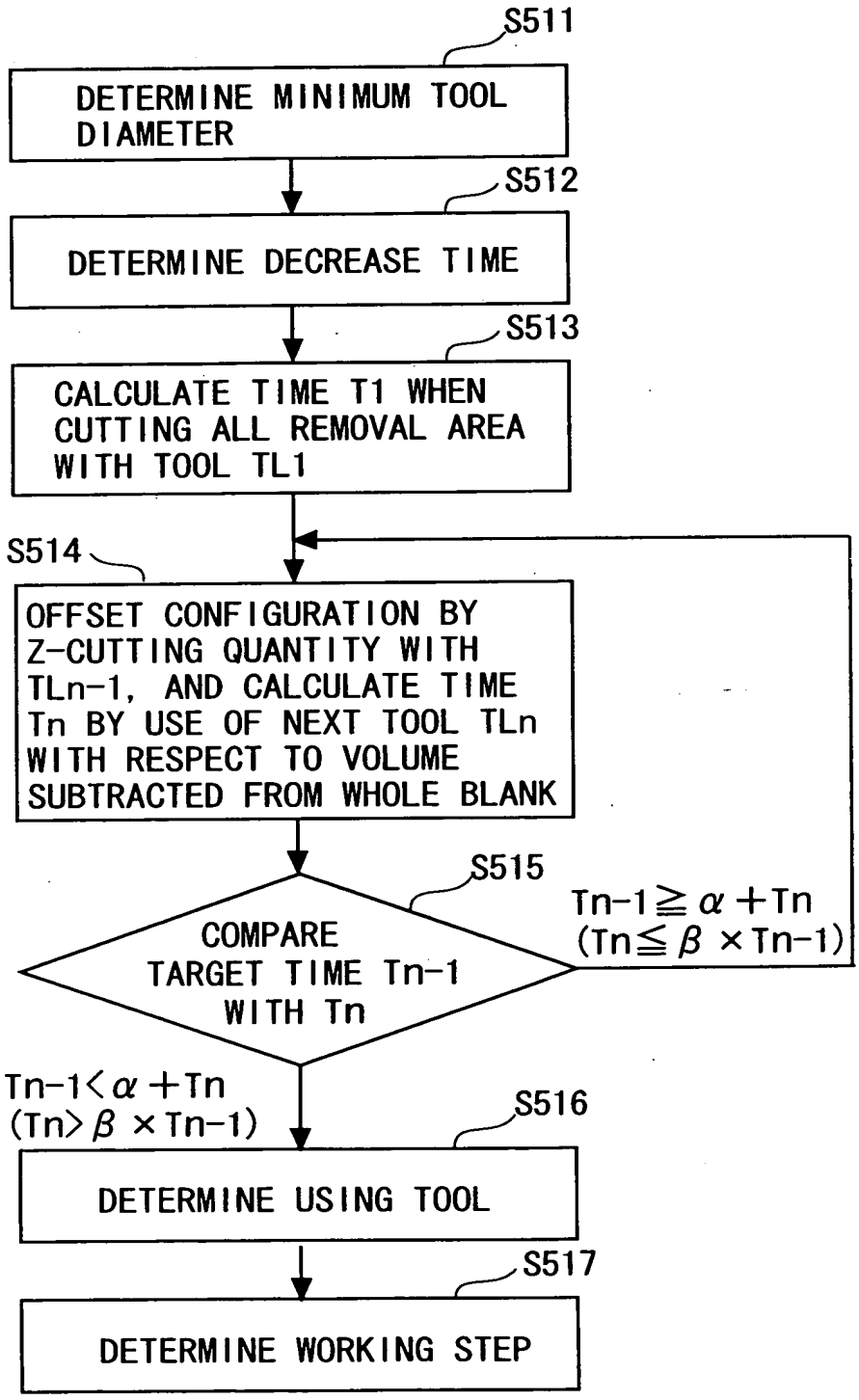


FIG. 39


S511
DETERMINE MINIMUM TOOL DIAMETER
S512
DETERMINE DECREASE TIME
S513
CALCULATE TIME T1 WHEN CUTTING ALL REMOVAL AREA WITH TOOL TL1
S514
OFFSET CONFIGURATION BY Z-CUTTING QUANTITY WITH TLn-1, AND CALCULATE TIME Tn BY USE OF NEXT TOOL TLn WITH RESPECT TO VOLUME SUBTRACTED FROM WHOLE BLANK
S515
COMPARE TARGET TIME Tn-1 WITH Tn
Tn-1≧α+Tn
(Tn≦β×Tn-1)
Tn-1<α+Tn
(Tn>β×Tn-1)
S516
DETERMINE USING TOOL
S517
DETERMINE WORKING STEP